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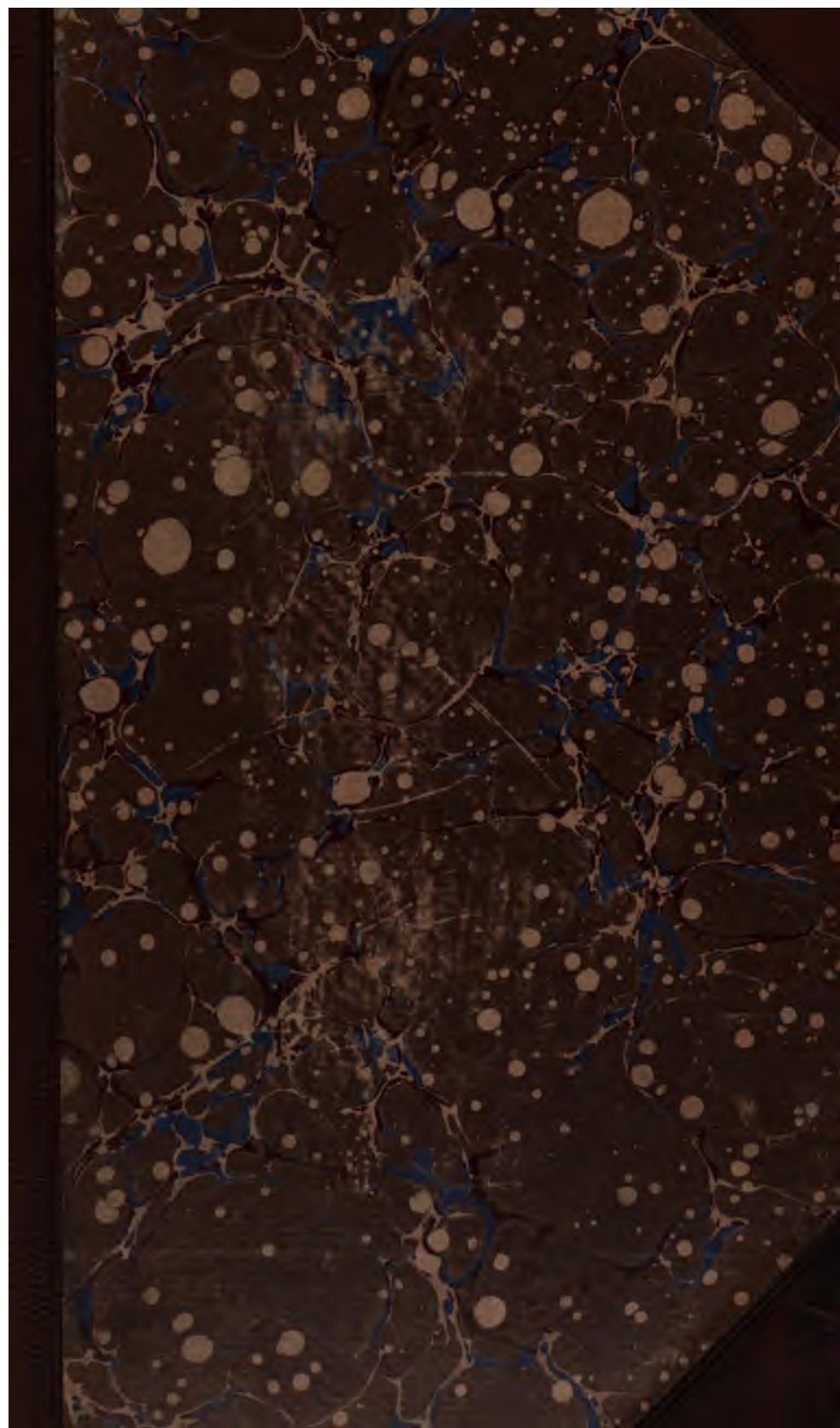
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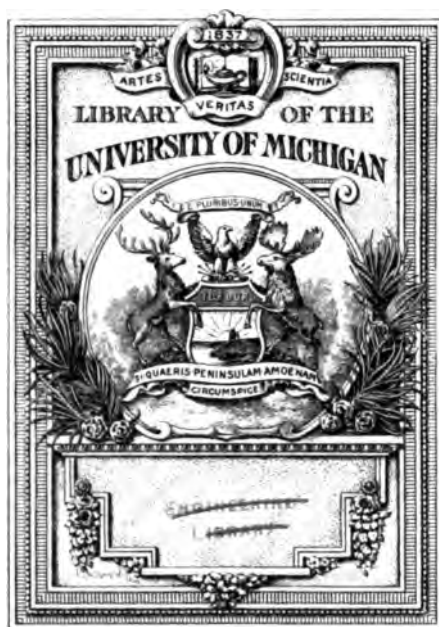
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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ESPRIT DE CORPS.—A TRACT FOR THE TIMES.

BY CAPTAIN CASPAR FREDERICK GOODRICH, U. S. N.

A careful search through the Proceedings of the Naval Institute reveals the singular and instructive fact that they contain no consideration of, if indeed any allusion to, the subject of this essay. Papers and discussions, abstracts from service and technical journals, hints and suggestions abound which touch upon or completely elucidate a multitude of topics incident to the profession. They range over the entire field of naval thought, and they form, taken together, an enduring monument to the wisdom of the founders of the Institute, as well as to the capacity and devotion of those who have guided its destinies since its formation. Without these precious volumes no naval library is to-day complete. The student may learn from them substantially all there is to know, in theory at least, about administration, types of ships, their armament and protection, their speed and coal endur-

ance, the details of their equipment, their use singly or in concert, the best method of educating officers and men, how to care for the latter in sickness and in health, etc., etc.; but of the necessity and means of cultivating that solidarity of sentiment which alone can put the breath of life into the ship or the fleet, considered as integers, never a word is spoken. The subject of a naval *morale* is not implicitly assumed; on the contrary, its very existence is either forgotten or deliberately ignored. A stranger to the service, who should seek diligently to acquaint himself with the essentials of naval practice, would rise from the conscientious study of these Proceedings without so much as a suspicion that there ever existed a body of unwritten law and traditions more potent than statutes and regulations in welding into a consistent whole the somewhat incongruous elements that go to form an organized navy. Yet every member of the profession knows, almost intuitively, that his relations to his associates, whether senior or junior, are governed by a rigid code peculiar to the Navy and dating back to time immemorial. It is a truism which, like many other truisms, it is well to revive and to repeat on occasion, that ships, however formidable in themselves, are measured in value by the resultant force of those on board. When officers and men act in harmony the result is happiness and efficiency. Where dissensions arise, and unity of effort gives place to the disrupting tendencies of opposing or selfish interests, the effect is at once manifest in a diminution of the fighting worth of the vessel or of the fleet.

In the Navy, *esprit de corps* is "the blest tie that binds." The essayist has thought that an inquiry into the reasons why *esprit de corps* has received so little attention from naval writers, an investigation into its nature and obligations, and a consideration of the consequences that attend its non-observance as well as of the profits that accrue from following its dictates, might be both timely and beneficial.

I.

The overwhelming necessity which has obtained, until a recent period, of rehabilitating our marine is conceded without dispute. To such a low ebb had our fleet fallen that the combined exertions and individual activities of all officers were imperatively demanded that we might build ships with the utmost practicable

speed and equip them with every device essential to the proper performance of their functions. We had reached a point when the very life of the Navy seemed at stake. Not to progress was to die. To the herculean task of reconstruction every person in the service brought his best energies and a zeal, an industry and an ability beyond praise. What seemed almost impossible at the outset was found entirely feasible, and to-day the work is largely accomplished. The writer is unwilling to yield first place in hearty recognition of both the end itself and the instruments by which it was achieved. But an apprehension has arisen that, in so entirely giving itself up to the material needs of the moment, the Navy may have insensibly drifted from its former standards of professional faith until the fact and need of a naval *morale* stand in danger of being overlooked. It would, perhaps, be inexact to assert that this apprehension has grown into certainty, but the vicious development of this vicious tendency is at times but too marked not to call for the serious attention of such of us as have given their best years and their best thought to the service, as well as of those who, coming after, must receive the sacred flame from our hands and in turn transmit it bright and pure to *their* successors. Is it not, indeed, time to acknowledge frankly to ourselves that, like the Israelites of old, we have wandered away to strange gods and that we must revert to the ancient and true worship, lest we perish?

In the absorption occasioned by the building up of our naval edifice afresh from its very foundations, a reason may be found for our failure to cultivate the less obtrusive virtues of loyalty and self-abnegation, which, if not altogether sufficient, may yet be urged in excuse with much apparent justice.

Another powerful cause of the present regrettable condition of affairs lies in the distressingly impeded flow of promotion which, condemning bright and capable officers to spend the greater part of their lives in subordinate positions, blights their energies and produces that most pitiable discontent, bordering on despair, which discerns no rift in the clouds, no prospect of near or distant relief. The prize of youthful ambition has ceased to attract, or, when gained, the palate is too jaded by long waiting to appreciate or enjoy it. Like apples of Sodom it turns to ashes in the mouth. It would seem idle to quote Goethe to these unfortunates,

“Entbehren sollst du, sollst entbehren.”

Even if the Navy List continues to remain unduly congested in places, the obligation still holds to bear our fate like men, striving to win better things, yet ready and willing to sacrifice our individual wishes and our personal comfort, working early and late, through doubt and discouragement, for that paramount object, the good of the service.

A third and hardly less potent occasion for this waning of *esprit de corps*, unless it may be conceived as standing rather in the relation of effect than cause, is the undue and wholly unprofessional exaltation of service on shore over service afloat. Time was when the goal of an officer's ambition lay in the commendable performance of duty on board ship. In the junior grades, to be considered a capable watch officer or navigator or executive or, later, to command a vessel or a fleet with ability and distinction, was deemed a sufficient recompense for toil and study, the ample crown of long years or a lifetime of sustained effort. The brilliant career of to-day, however, is measured but too often by the number of important and desirable positions occupied when *not* at sea.

Some apology for this erroneous and distorted view might have been brought forward when our ships were obsolete in type—the laughing-stock of the maritime world—and, in truth, it was during that period that sea-going was least in favor. A better spirit is now beginning to prevail, and the fact that sea duty is our chief concern to be generally admitted; but it is difficult to overcome the evil results of a false standard so long tacitly, if not openly, acknowledged; or to forget that it was not many years since officers were threatened with orders to sea as a punishment. We are, unhappily, still familiar with rather recent instances of officers who have deliberately elected service on shore in preference to service afloat, even at the loss of professional standing. Such cases should be to us as warnings rather than examples.

The long period of uninterrupted peace which the nation has enjoyed since the Rebellion, and for which as patriotic Americans we should be and are profoundly thankful, has exerted a powerful influence on service opinion, through the lack of opportunities for the display of personal prowess and professional skill in the operations of war. The ambitions of individuals have, perforce, sought their outlet in enterprises more in consonance with the

prevailing sentiment of the hour. Denied, unfortunately as naval officers however fortunately as citizens, the chance for honor and advancement offered by hostilities, we have turned our activities into other channels and have found their scope in the more immediate, yet vastly less important matters of design and construction, and particularly in the administration of affairs, the chief, if not the only, means to-day of achieving distinction. No laurels adorn the brow of the faithful and capable sea officer. He has but the reward of an approving conscience, and he counts himself fortunate if he escapes condemnation for some trifling dereliction or for some assumed error of judgment. He has but done his duty.

Since the routine of ordinary cruising rarely if ever presents occasion for the manifesting of the larger capacities, he who would be reckoned something more than his fellows must, it would appear, look outside and beyond his ship. Be not deceived; the reputation of no naval officer can be considered enviable or exemplary which is not based upon an excellent record at sea. Lacking this condition, brilliant appointments on shore are but as sounding brass and a tinkling cymbal, as evanescent as the noise produced by this scriptural orchestra. The essayist looks confidently to the time, and that in the near future, when the so-called prizes in the gift of the Navy will be reserved for those who have well discharged their duties as sea officers, and when a large credit in the column of the Navy Register entitled "sea service" will be regarded as a token of departmental approval. A general desire to go to sea will be followed by as general a determination to make the ship all of which she is capable in good order, efficiency and discipline; and by the re-adoption of *esprit de corps* as the sole instrumentality by which this end can be reached.

If further proof were needed of the comparatively low esteem in which sea-going has been held, it would be found in the fact that in years not long past the reward of the highest standing at the Naval Academy, an institution founded for the sole purpose of training naval officers, was assignment to a corps which has nothing whatever to do with the handling of ships and men. Such an exaggeration of the importance of the tool itself over that of the man who uses it is difficult to explain.

"Historically," says Mahan, "good men with poor ships are

better than poor men with good ships; over and over again the French Revolution taught this lesson, which our own age, with its rage for the last new thing in material improvement, has largely dropped out of memory." *

While due allowance should be made for personal taste, many able men possessing a marked and insuperable bent for mechanical pursuits, it is unjust to the service and to the individual to encourage the notion that the human element is, or ever can be, subordinate in naval affairs to the machinery by which that element is aided in its labors, and through which it may make or mar the destinies of the nation. It has been truly said, "The ship is measured in its value by the value of the man who commands it." To pass voluntarily into a non-military corps therefore was a tacit acknowledgment on the part of the graduate of the Naval Academy that, while especially gifted in certain admirable mental attributes, he was deficient in those more sturdy qualities which characterize the successful naval officer, or else that he valued the larger salary of the constructor above the wider opportunities for power, distinction and usefulness afforded by a naval career.

In view of the hearty, earnest and, let us hope, successful efforts now making to remove by wise legislation some of the unnecessary and wholly unpleasing differences to be found in the naval service, it has become possible, at the very last moment of writing, to suggest what previously discretion and a regard for the susceptibilities of others would have barred out of the essayist's treatment of this question. Even sentiment requires something tangible for its sustenance, something real to which to cling. May not one reason for the rather lax condition of *esprit de corps* be found in the fact that pay has been greater and promotion more rapid in certain of the non-military branches of the Navy? In this sordid age when men measure things and, alas! other men, by their money value, their financial equivalent, the captain of a ship has not infrequently been less well paid than a junior under his command. Has this been seemly in itself or calculated to increase his self-respect? Men are but human after all. While they need not be unduly rewarded for the performance of duty, however onerous, still the latter should not be rendered irksome

* Mahan, Rev. and Emp. I, 103.

through receiving less practical recompense than that of a subordinate whose functions are not in the least military and whose responsibilities are, comparatively speaking, insignificant. The military duties of the profession ought to be first and foremost. It is for them that the Navy exists. The *morale* of the service must necessarily be unfavorably affected by every distorted appreciation of the importance of non-combatant performance.

The causes briefly alluded to, with others less obvious which it is bootless to investigate, have combined to produce a faulty conception of the service as a whole and a notable diminution of the force and recognition of that sound and healthy *esprit de corps* which it is our duty singly and collectively to foster and to encourage. No more pressing call exists to-day. None are too old to turn again to the true cult, none too young to grasp its essentials and to devote themselves earnestly and faithfully to its exercise. It is the soul of the Navy, and ours, from the junior cadet to the senior admiral, the charge to "save that soul alive."

II.

Living as we do at the close of the nineteenth century, and perceiving on every hand the signs of a complete revolution in the ideas which govern the relations of individuals to the State and to each other; watching the growth of new political doctrines which seek to reduce all members of society to one plane of dreary and uniform equality irrespective of innate capacity or external condition; recognizing the impatience with which the few remaining marks of differentiation between man and man are regarded, and the steady loss of influence on the part of that class of citizens who on account of their birth, education and moral elevation would, in the ideal community, be entrusted with the largest measure of the powers of government, we are unconsciously affected by the medium in which we live, and are likely, if unresisting, to be borne along by the swift current of general unrest towards the rocks upon which will be shattered the little that is left of respect for authority and reverence for our elders. It is not my purpose to discuss or even question the soundness of this new sociological development as touching the world at large, but as to its effect upon the organization to which we belong there can be but one opinion. Our only safe guide is experience. The history of the French navy under the Directory is conclusive on

this point.* Whatever be the conditions that hold in civil life, the precedents of generations of naval officers must, in the main, be our rule in the present and for the future. These precedents may, with propriety, be traced back to and in the British navy from which we drew our early laws and usages. The *physical* continuity is confessedly interrupted, for our navy was not formed, as naturalists say, by fission—the dividing of a parent stem and the splitting off of one or more complete vital units—but the *moral* continuity is unbroken.

What was the fundamental motive that governed England's naval leaders? The answer is not far to seek. Loyalty to the Crown.

It is impossible to read such of the writings of England's great sailors as have been transmitted to the present day without observing the frequent recurrence of expressions that breathe this sentiment. While these phrases may occasionally be a form of speech as common and unmeaning as the "Your obedient servant" at the end of a letter, which is but now disappearing from correspondence, they are often encountered in such connections that they can only be interpreted as involuntary outbursts of genuine feeling. Thus Drake, in submitting "A Relation of the Rare Occurrences &c" to Queen Elizabeth, speaks of it as "a worke to him no less troublesome, yet made pleasant and sweete, in that it hath bin, is, and shall be, for your Ma^{ty} content, to whom I have devoted my selfe, live or die."† The courtier in Drake never overshadowed the venturesome hard-fighting sailor to whom God's truth and the air of a bloody combat seemed equally essential conditions of a Christian life.

The same devotion is to be seen in his letter to Walsingham announcing his departure for Cadiz. "The wynd commands me away, our shipe is under sayell, God graunt we may so live in his feare, as the enemy may have cawse to say that God doth fight for her Majestie as well abroad as at home, and geve her long and happye lyfe, and ever victory agaynst God's enemyes and her Majesties."‡ It is difficult to rightly apportion the various ingredients in this quaint prayer—ambition, love of fighting, and loyalty—yet that all three are to be found therein cannot be denied.

* See Mahan, *Sea Power in the French Revolution and Empire*, vol. I, chap. II. † Barrow's Drake, p. 38. ‡ Barrow's Drake, p. 221.

When Sir Edward (afterwards Lord) Hawke was given the thanks of the House of Commons for his splendid action at Quiberon he replied, "In doing my utmost, I only did the duty I owed to my King and my country, which ever has been, and shall be, my greatest ambition to perform faithfully and honestly to the best of my ability."

With us, as Americans, it is love of country which should supply the place of a feudal or monarchical loyalty and furnish an incentive to brave deeds and patient suffering. That the object of the new devotion is less worthy than that of the old no one can fairly claim. For a sovereign, possibly lacking in all the attributes of kingship save the sceptre and royal purple, we may substitute our native land, the seat of our joys and sorrows, the mistress whom we stand ready to serve through good and evil fortune, in prosperity and calamity. As a distinguished officer happily expresses it, "The bed-rock of a naval service is organization; its soul, honor; its demand, courage; its inspiration, love of country." *

If we be willing to offer up our lives for our native land unquestioningly and as dutiful sons, surely we ought not to begrudge those daily sacrifices and minor offices which, distasteful as they may be, are the *sine qua non* of true discipline and an efficient organization. †

This general rule of conduct will be admitted by officers without exception as admirable and exact. It is a truism which none can deny, and to the inert it appears so delightfully vague as to involve no possible risk to comfort and peace of mind. Without question then we all agree to it. But if we do, what follows then? Does it carry no mandate that shall control our actions? Such a moral principle once accepted *must* impose conditions that we are powerless to evade. A little reflection will show that, far from being a transcendental speculation of no real effect, it is or should be a living force influencing every official thought and deed. It commands us to be diligent in making ourselves useful servants through painstaking study of all that relates to the

* Rear-Admiral Belknap, U. S. N., in "Some Aspects of Naval Administration in War, with its Attendant Belongings in Peace."

† The Secretary of the Navy says, "There are men who would count their lives as nothing beside their country's need, yet pull apart 'like a balky team' in the homely adjustments of ordinary work."

theory and practice of our profession, and it lays down certain lines along which the discharge of our several duties must proceed if we would be true to ourselves.

Granting the obligation in abstract terms, how shall we apprehend its concrete embodiment? There can be but one answer—in cheerful obedience to and hearty co-operation with our immediate superiors. The links in the chain are complete and the chain itself continuous, stretching from the President as Commander-in-Chief, through his administrator, the Secretary of the Navy, the commander-in-chief of the fleet, the captain of the ship, the executive officer and the other heads of departments and their subordinates, down to the most insignificant person of the crew. Upon each member of the hierarchy the moral law, already defined, presses with an insistence which only ignorance or wilfulness refuses to recognize.

To every individual in the naval profession, no matter what be his position and his responsibility, there is granted a horizon of labor and effort plainly marked and unmistakable in the sunlight of a patriotism which takes the local guise of a sense of duty. In the words of our great and good Farragut, "I will do my duty to the best of my ability, and let the rest take care of itself." "Duty," said Nelson, "is the great business of a sea officer." And in his last hours his departing soul was cheered by the reflection to which he gave expression in those noble words, "Thank God! I have done my duty."

Nor was this sentiment confined in its exercise and its bearing upon his life to the occasional crises which have rendered his name immortal. Even a Nelson had his dark days when his most strenuous efforts appeared fruitless and unappreciated. To his ability, courage and perseverance was chiefly due the capture of Bastia, for which he won from the Commander-in-Chief, Lord Hood, only an equal share of praise with his junior who commanded a single landed battery. Yet Nelson, suffering from the keen disappointment and wounded pride which belonged to his sensitive nature, could write to his wife in that entire confidence which permits the utterance of the inmost thoughts of the heart, "However services may be rewarded, it is not right in an officer to slacken his zeal for his country."

"Whatsoever thy hand findeth to do—do it with all thy might." As with the servant in the parable, who being faithful in a few

things was set over many things, the reward is inevitable. To every man a task is allotted by his immediate superior, and he serves his country acceptably and well who performs that task with tireless energy and inflexibility of purpose.

The task may not be agreeable in itself; it may be opposed in nature or method to one's most cherished professional convictions. If it seems fraught with harm, a proper representation to the senior is of course obligatory.

A hearty and prompt obedience is not only right in itself but right also in its far-reaching effects.*

Be patient! to all a day must come when they in turn shall direct. Happy for their subordinates if they remember their former woes and are as considerate in the exercise of power as they once thought their superiors inconsiderate. If they have served with loyalty while inferiors, naturally and easily will come to them the enjoyment of a like loyalty in the hour of their elevation. But if they have previously failed in this respect, how shall they expect to be served with a loyalty they were unwilling to render? They have sinned against *esprit de corps* and their punishment will consist in finding their orders executed to the letter, yet broken in the spirit, and in encountering the same sullen and dogged opposition which it was previously their delight to offer.

The Golden Rule is not banished from the Navy. Quite the contrary. The successful captain was guided by it in his youth when he did for his superior what as a superior himself he would have liked his subordinates to do for him, and he reaps his reward in that harmony of official thought and deed exemplified in the *morale* of the British fleet at the Battle of the Nile. "I had the happiness to command a band of brothers," said Nelson in reporting his victory—possibly the greatest ever achieved afloat. This sentence is both the embodiment and the exemplification of *esprit de corps*. Never have the results of this vital principle been more happily illustrated. To such a fleet, so commanded, with officers and men all animated by the mutual respect and confidence born of a sound naval *morale*, nothing, absolutely nothing, was impossible. The French ships were doomed from the first

* As naval officers we should be proud of the cheery expression "Ay, ay, sir!" the finest ever invented for the acknowledgment of an order. It is commended as a fruitful text to the coming generation of graduates of the Academy.

moment of pursuit, and their destruction would have been equally complete no matter where encountered. Not the least of Nelson's qualities as a great captain was this faculty of arousing enthusiasm for the common good—a readiness to do and to suffer. In his hands *esprit de corps* was a potent instrument to move men's souls and to elevate even the baser of his confreres to the highest plane of professional honor.

The essayist suggests that no better definition of *esprit de corps* can be found than in the sympathetic reading of this famous despatch. We cannot all be Nelsons, but we can and must be a band of brothers.

III.

It is not a pleasant task to hold the mirror up to nature and to reveal to their owner the blemishes which mar the countenance; still less is it agreeable to acknowledge our own faults and weaknesses; but a frank recognition of our shortcomings must precede, indeed it is the first step towards, their correction.

To run over the gamut of official error is, however, neither necessary nor desirable. A few instances that may be described in general terms will abundantly suffice for the purpose in view. The essayist has thought it inexpedient to state his case in full, and, on the other hand, he has not felt at liberty to assume that its proof will be conceded without question in the forum of service public opinion. In thus attempting to avoid Charybdis without falling upon Scylla, he has ventured to rely upon a friendly sympathy with his motive, which is to aid the profession in remedying its faults and yet not to paint those faults in needlessly sombre or alarming colors. He would indeed greatly deplore the application of any remark of his, designed avowedly to describe but an exception, to the establishment of a general rule. The majority of the *personnel* in our own Navy is animated by right sentiments in the main. Of the minority, again, the larger portion is readily amenable to influences that make for good. While the essayist is justly proud of the profession of which he is a humble member, he cannot blind himself to the fact that some improvement still remains possible before it reaches that high plane of thought and feeling of which it is abundantly capable. A little of specific exposition of its needs appears therefore desirable and pardonable.

We are all but too familiar with a type of officer which is the inevitable product of a systematic, if unwitting, attempt to substitute narrowly defined regulations for the broad and comprehensive operations of *esprit de corps* and service traditions. Many there be who study the letter of these printed ordinances; but for one who seeks in them enlightenment as to his duties and responsibilities, others will be found who look only for a statement of their rights and privileges. Such officers, in short, devote the time spent over them more especially to ascertaining rather what others may *not* do than what they *should* do, and they arise from their investigations better equipped for blocking than for facilitating the work which all must execute.

It is not meant to imply that the safeguards with which the regulations surround the exercise of authority, in the interest and for the protection of the subordinate, are to be disregarded. On the contrary, they are wise and salutary, for the superior is not always exempt from the failings of human nature; but they can be made harmful if the dominant fact be overlooked that they need only be appealed to when an evident disposition is manifested to forget that while great power is given to the superior there is attached to this great power the obligation to use it for the good of the service and not to the prejudice of the individual.

The officer of the type developed through this one-sided study of our book of regulations sets up to be an oracle on such matters; he announces that he will not obey such and such orders if given, he is a focus of incipient mutiny, a thorn in the side of his superior, a nuisance to his messmates, and he is seldom, if ever, a good officer.

This is no new doctrine. Fifty years ago Captain Liardet wrote in his admirable "Professional Recollections," "Those who cavil most at the orders of their superiors while they themselves are in a subordinate situation, are almost invariably the most tenacious and overbearing to others when in command themselves. The heart and soul of all good naval discipline is strict obedience to orders; and when any officer habitually deviates from this principle, whatever his rank or abilities may be, he cannot be considered of any value to the public service. To insure the *morale* of the Navy, officers are now called upon more than ever to be scrupulously careful in their conduct; as captains

and senior lieutenants, in the present day, have quite enough to do to uphold the discipline of their ships, without having to contend with insubordination from those who are expressly appointed by the Admiralty to assist in carrying out all things for the good of the service with energy and zeal." The officer under study devotes so much time and thought to the pastime of preparing a pitfall for his seniors that he has little or none left in which to learn the duties of the position he occupies on board. Fault is found with some minor negligence on his part, the regulations are invoked as a shield, and friction arises. He is rarely capable of separating his official and personal relations, so that a rebuke almost invariably turns him into an enemy watching with the eye of a hawk for the first mistake committed that shall furnish the occasion for a report to a common superior.

Instances again are stated to have occurred where one officer profited by another's shortcomings to himself break the rules of the service, in conscious security against charges that could be met by counter-charges of equal or greater severity. To hold over an erring brother the threat of publishing his frailties or his derelictions is an offense only possible on the part of an officer lacking in the elementary notions of *esprit de corps*. He is disloyal to his messmate in thus whetting his knife for a covert thrust, and he is disloyal to his profession in condoning an offense which, in his judgment, would, if known, be visited with severe punishment and which, therefore, must be of serious nature.

It is of course difficult to lay down a hard and fast rule of conduct in such cases, for *esprit de corps* has two phases, the major reflecting the service as a whole, the minor touching the relations between individuals. If each officer were constantly on the alert to report every infraction of the regulations on the part of others, life on board ship would be intolerable. A generous sympathy is obligatory on all, but when the safety of the ship is imperiled, or when her good name is jeopardized by wanton action or notoriously scandalous behavior, the offender forfeits his claim to consideration and he must be sacrificed, regretfully if you please, but none the less inexorably, to the necessity of maintaining the general reputation for high aims and clean living. There can be no doubt as to what to do when the question assumes the definite form of choosing between

the individual or the service, yet we can all adduce instances wherein an undesirable or even a disreputable person has been persistently screened by his shipmates under a faulty conception of *esprit de corps*.

Certain ships in the Navy have enjoyed the unenviable reputation of being "unhappy."* It is believed that in nearly every such case the fault lies with the officers themselves. Instead of devoting their energies to making the vessel efficient, each in his own way and branch, they have sought to undermine the central authority, and have even gone to the forbidden length of sitting in open judgment on their seniors. The essayist is the last person in the world to seek to deprive his colleagues of that blessed privilege of growling which is dear to the hearts of all that go down to the sea in ships. There are indeed some kinds of growling which furnish harmless relief, like a prompt safety valve, or which produce amusement and a healthy intellectual competition after the most delicately imaginative figures of descriptive speech. These are permissible, if not actually necessary and salutary. But personal growling against the superior, for example, and sarcasm and dispraise, are under the ban. These are dangerous and they must be eliminated. How much better is it to recognize the necessity at the outset and refrain from contracting habits that bring us questionable pleasure, no benefit, and certain trouble.

As a matter of fact, the general happiness of a ship depends less upon the temper and whims of the captain than is generally supposed. Vastly more important in this connection are the good fellowship of the officers themselves and the character, strength and tact of the executive. Blessed is the ship where the first lieutenant is strong and courteous, able and considerate. He fosters that sentiment of loyalty to the ship, the captain and the admiral, without which the cruise would be dreary indeed, and he sets an example which influences the professional life and development of every youngster on board. With such an executive it matters little for the atmosphere of the vessel what may be the captain's idiosyncrasies. The coming generation of officers can find no better diversion than in planning how they shall shape their professional growth in order to command,

* A stronger phrase is not uncommon.

when executive, the respect of their equals and juniors and the entire confidence of their commander.

There is, by the way, no method devised by Satan so infallibly certain to destroy the happiness of a ship, so contrary to the dictates of *esprit de corps*, as the open discussion of superiors. Servants have been the reporters of such conversations since Noah's time, carrying their accounts forward to the ship's company, where nothing is lost in the telling, with a regularity and a zeal which could well be devoted to better employment. Nor is this the only harm done. Such criticisms produce loss of respect for the seniors, and a readiness to take umbrage, which exert a baneful effect on the tone of the entire vessel. They are without justification in themselves and they offend against *esprit de corps*. No ship has ever been happy or efficient where they are tolerated. Lord Collingwood is said to have written, "All mutinies are started at the ward-room table."

Says Captain Griffiths in his work on Naval Economy, "But that officers should sit down in the presence and hearing of their servants, sentinels, etc., and use disrespectful language against their superiors (particularly their captains) must at once appear so self-evidently improper, so subversive of all discipline, so calculated to provoke insubordination and mutiny, that it would be idle to dwell on the subject." *

The essayist begs to be understood as showing by his quotations from foreign writers that our own Navy has by no means the monopoly of the defects mentioned. Moreover, from personal experience, we are all aware that other services are similarly affected. The reason may be deep-seated in the nature of the seafaring man. None the less would it be gratifying if the Navy of the United States could claim the role of exemplar in this matter of naval *morale*. To this end a solemn sense of duty should impel us. Nor is the end remote or difficult of attainment. We have but to will it and the prize shall lie in our hands. This is no figure of speech. Our case has already been passed upon in the highest court and judgment pronounced upon us by a keen yet kindly critic.

Says the Secretary of the Navy in his Annual Report to the President for the year 1897:

* Quoted, with approval, in Liardet's Professional Recollections, p. 288.

It is a pleasure to report to you the high character and fine sense of duty, the professional attainments, and patriotic spirit of the great body of officers of the line and staff of the Navy and Marine Corps. The whole impulse, from their entrance into the service at the Naval Academy, is to develop not only efficiency in the performance of duty, but variety and breadth of ability and culture. They have the liberal education of extended foreign travel. Their employment necessitates the study not only of international and commercial relations, but also of modern scientific forces and their application to the practical demands of a great department of the national life.

Naval service is not limited to the sailing of a ship and the firing of a gun. A modern man-of-war is a compendium of industrial inventions and appliances; a business and manufacturing plant as well as a fighting machine. A large part of its crew is engaged in skilled labor—the running of engines and the movement of machinery. An officer's duties, and the demands upon his professional resources, whether in the movement of ships or in the work of the mechanical departments connected with their make and repair, involve problems of construction, the use of the dynamic forces of air, water, steam and electricity, and the nice adjustment of batteries, guns and gear of enormous tonnage, yet moved on hair lines and by a touch of the finger.

All this calls for advanced requirements on the part alike of those who command and direct, and of those who construct and operate. The responsibility that attaches to the captain of a single battle-ship, or to the admiral who commands a fleet, necessitates the greatest resources of skill, prudence, discretion and education. To these demands the Navy rises. Whether serving on shipboard, or in the important work of instructing our naval youth, or studying war problems, its officers in every line of the naval establishment deserve the public confidence.

There are, of course, sporadic cases of demerit. There is now and then an officer guilty of excessive use of intoxicating liquors, a fault which is simply unpardonable, in view of his responsibility for life and property and of the importance of his example to the men under his command, and which I know you are determined to punish with unrelenting severity. There is the occasional shirk, the seeker for soft place, the nerve-worn hesitant, the petty despot. There are cases, happily rare, of pecuniary dishonesty or untrustworthiness. It is the function of the examining boards to weed out all these elements and prevent their promotion.

There are also, sometimes, petty frictions and jealousies which make one long for the high mind. There is too often an inclination on the part of some officers, when a new question or exigency arises, to consider with aggressive and sometimes petulant zeal its bearing upon their special position, or command, or corps or bureau, or station, lest they lose or somebody else get a thin slice of authority or jurisdiction, whereas their always first and paramount impulse should be the best interests of the whole service—a text that ought to hang on every eyelid in the Navy. There are men who would count their lives as nothing beside their

country's need, yet pull apart "like a balky team" in the homely adjustments of ordinary work.

The rigid economy which, in view of the large and growing expenses of the Navy, ought to obtain in every detail of naval expenditure, is sometimes lacking, and the Department is making special effort to keep the importance of its necessity in the mind of the service.

There have been two or three courts-martial held upon offending officers, the results of which are monuments of either stupidity or favoritism.

But these exceptions only prove the rule, and the great body of our naval officers, especially the sifted wheat of it which would be selected for responsibility and command in case of emergency, are men of marked worth and of the best type, ready at any hazard of life or fortune to go anywhere, brave any peril, do any duty—qualified to serve their country not only in war but in the more varied arts of peace. Their standards are high, their zeal ardent, their courage and ability adequate to any demand, and no crisis can come in which they will not prove themselves in every respect the equals of the most illustrious names in naval history.

The essayist asks his brother officers if praise could be more generous or blame more gently and justly urged than in these notable words? We should be unworthy of the exalted place which, as a body, we are privileged to occupy in the regard of our official chief if we failed to respond to his demand to correct our faults and to weed out from among our number the shiftless, the drunken and the incompetent, the insubordinate—"the occasional shirk, the seeker for soft place, the nerve-worn hesitant, the petty despot." When we shall have done this and warranted the Secretary of the Navy in rewriting this section without its qualifications, we shall be able, if our modesty does not forbid, to pose as a model to our rivals of other flags. Until then, a becoming humility is more in consonance with our merit.

The "high mind" longed for in the report, be it remarked, is but the wider manifestation of *esprit de corps*. It is not often than an obscure writer for the Proceedings of the Naval Institute, after toiling for a year or so, finds, at the eleventh hour of his composition, that his plea is adopted by the Navy Department itself and presented in words so frank, cordial and forceful that they must inevitably prove of immeasurable and immediate effect. As to the future, and of his encomiums, we may indeed say with Virgil,

"Hæc olim meminisse juvabit."

For a rule of action, then, the all-sufficient criterion when doubt arises as to what it is best to do under certain conditions

is the good of the service. Whatever militates against that is wrong; whatever makes for it is right. "The best interests of the whole service are a text that ought to hang on every eyelid in the Navy." If we are guided by such a code we cannot go astray. To the good of the service we are bound by the obligations of a patriotism which it should be our pride to acknowledge as the rule of life, no less imperative now than was the personal loyalty to the sovereign which animated the great sailors of old.

IV.

From the instances briefly cited, which, if such multiplication were necessary, could be added to from the experience of those who have had the patience to read these pages, it is fair to draw the inference that *esprit de corps* is the moral foundation of the edifice of naval efficiency as well as the inspiration of individual success. Where *esprit de corps* is present the ship is harmonious and well disciplined; where it is absent, discord and inefficiency prevail. Sound organization demands the concurrent efforts of all towards a common end, the good of the service; in other words, the recognition and guidance of *esprit de corps*. The seaman's art is valueless and his education is incomplete without it. There is no part of an officer's obligations and duties more vitally essential than the cultivation of this cardinal principle. By precept and example it should be especially drilled into the minds of those just embarking upon a naval career, until it becomes a second nature, entering into and controlling every act. Only to those who carefully take its lessons to heart is the full fruition of a naval life possible. It is the a b c of the profession, the primer of our art.

Every ship is a school that leaves the impress of its tone and teaching upon its graduates. An officer is either the better or the worse for every cruise he makes, for official contact with every superior.* *Qui non proficit, deficit*. We must either advance or retreat; we cannot stand still.

As has been finely expressed, in one of those great addresses

* Thus Commodore Charles Morris, in his Autobiography, says of Lieutenant Daniel Murray: "My subsequent improvement may, in a great degree, be fairly attributed to his influence, and the elegance of his manners, his cheerful and amiable temper, and his high and firm principles furnished an example which excited a desire and even an attempt to imitate."

which have justly won for their author the admiration of all privileged to listen to his periods glowing with life and truth, "The impression we cast upon those that pass within our shadow they carry on forever. The very words they speak have immortality. . . .

"And our immediate influence! This touch of life upon life: how wonderful it is! Something of character always goes with it. If the blacksmith puts some indefinable quality of himself into the iron he shapes, if the printed page in order to reach its highest artistic perfection must come from the direct touch of the printer's hand upon the press, how much more do human souls take from us impressions of character? And that which fixes the impression, that which is the impression, is character. The trade, the art, the profession, being learned, that which more than anything else does the work is character. Character is in the carpenter's strokes upon the nail, it is in the sailor's pull upon the rope, it is in the officer's orders upon the deck; it commands the ship, it paints the picture, it delivers the oration, it writes the book; it is the finest quality of gifts and of life. . . .

"All we do must live on. Evil deeds must have a wicked immortality. . . .

"But the cheering thought is that whatever is good in us shall likewise have tenacity of being. The moralities and virtues of our lives, the generous acts, the good dispositions that have marked them, . . . must all live as seeds in the world. Not seeds garnered and locked up in the inclosure of single lives; but seeds scattered abroad, that become in their fruitfulness the blessing of all."*

This reflection brings home to all of us the sense of a grave responsibility. Through our example, if not through our precepts, we are unconsciously instrumental in shaping the careers of those around us. We may stand for good or we may stand for evil. That we should stand for nothing is forbidden us. Whether we will or no, we are apostles of, or apostates from, *esprit de corps*. It becomes our charge, then, "to show in ourselves a good example of virtue, honor, patriotism and subordination," as our naval bible phrases it, and to indicate to others the path that leads to professional usefulness and honor.

* From a sermon delivered at the Naval Academy, by Chaplain Henry H. Clark, U. S. Navy.

The theme is not a new one. Our great Farragut illustrated it in every act of his life, as the midshipman ten years old and as the admiral of nearly seventy. A more painstaking student of his calling never existed. His fund of varied information was astonishingly extended, but whatever he learned was with the sole view to increasing his value as a naval officer. Other ambition he had none. His extreme modesty restrained him from pouring out his soul, even in his diary or intimate correspondence, as did Lord Nelson, his only rival in our esteem, so that we are unable to quote his own words in proof of his motives and must find the mainsprings of his deeds in the deeds themselves. "The moral of Farragut's life," says his biographer, "is that success is never an accident; that the surest way to become great is by rising to the top of one's profession, thoroughly mastering the duties of each grade as it is reached. To such a man, fame, if it comes, is but an episode; his mind is fixed solely upon the full development of his powers and effective performance of his appropriate work." It would almost seem as if Farragut had shaped his course by that admirable code laid down by Collingwood to a protégé in a letter which all young officers should commit to memory. "A strict and unwearied attention to your duty," said he, "and a complaisant and respectful behavior, not only to your superiors, but to everybody, will ensure you their regard. . . . Guard carefully against letting discontent appear in you; it is sorrow to your friends and triumph to your competitors, and cannot be productive of any good. Conduct yourself so as to deserve the best that can come to you. . . . Let it be your ambition to be foremost on all duty. Do not be a nice observer of turns, but forever present yourself ready for everything; and if your officers are not very inattentive men they will not allow the others to impose more duty on you than they should; but I never knew one who was exact not to do more than his share of duty, who would not neglect that when he could do so without fear of punishment. . . . Remember, Lane, before you are five and twenty you must establish a character that will serve you all your life."

Of another he wrote, "If he takes no more pains in his profession than he has done he will not be qualified for a lieutenant in sixteen years, and I should be very sorry to put the safety of a ship and the lives of men into such hands. He is of no more

use to us here as an officer than Bounce * is, and not near so entertaining. . . . He is living on the navy, and not serving in it." Let us hope that this last remark is applicable to few, if any, of our number.

Commodore Morris writes of himself: "By great perseverance I acquired the ability to read French with facility, and then used works in that language to read history and study naval tactics and other subjects connected with the higher branches of my profession." Morris's careful devotion to the acquisition of nautical knowledge saved to our navy its most famous frigate, for it was by his suggestion that the *Constitution*, of which he was the first lieutenant, was warped out of gunshot from the chasing British squadron in 1812. He ascribes the subsequent victory over the *Guerriere* to "the unwearied exertions of our officers to devise and bring into daily exercise every important improvement which might increase the chances of success against a navy, to which we might soon be opposed as an enemy, and upon which there were so many injuries and insults to be avenged for the honor of our country. This expectation and feeling were of general, almost of universal prevalence among our officers, and led them to a unity of purpose and action which could not fail of producing important results. Their number was so small that each knew almost every other, and there was scarcely a feeling of unworthy jealousy, though much of generous emulation, among those of corresponding ranks." It was Nelson's "band of brothers" again, but conservatively expressed as became Morris's more self-contained and less expansive nature.

It is impossible to read the lives of the great sailor captains of our own as well as of foreign navies without being profoundly impressed with the fact that their laurels were won only through the seizure of the happy opportunity for which their whole previous career had been one long preparation, in careful study and practice of their profession and in cultivating that loyalty to the service and to each other which alone could make their study productive.

It was the contemplation of Farragut's character which led Admiral Belknap † to write: "Ah! that is the sort of men we want Annapolis . . . to turn out. A man who knows his own mind, has the courage of his convictions, believes in himself,

* His dog.

† Op. cit. sup.

and in the loyalty, devotion and intrepidity of the officers and men he commands under any circumstances of peace or war. An officer whom to know is to love, whose subordinates, in their great trust and supreme devotion, will follow to the death."

The essayist suggests to his brother officers that among the many benefits that will flow from a revival of the ancient cult is an improvement in their material conditions.

As a body, we labor under many unnecessary disadvantages and hardships from which we ought to be relieved, that the maximum efficiency of the fleet may be attained. Pay and promotion, for example, are legitimate subjects upon which to urge remedial legislation. While, as suggested by Mr. Secretary Long, something is possible through rigid examinations that, by weeding out the unworthy, shall at the same time benefit the capable and faithful, the limit in that direction is soon reached. A reasonable petition for help out of our troubles would then be in order, and, coming from the entire naval organization as a unit, it could not fail of its purpose. One need not be a prophet nor the son of a prophet to assert that there will be no marked change in existing naval law under these heads until the Navy speaks as with one voice.*

If the essayist has seemed unduly strenuous in claiming importance for the efficiency of a naval *morale*, it is because, in this materialistic age, the transcendental and less obvious condition is overlooked, and the underlying motives and the indispensable medium of mutual confidence, in which these motives work to the desired end, are unacknowledged, if not unperceived. Just as in all human actions there are the body, the mind which guides and the soul which animates—so in naval affairs there is the ship herself, her drills and discipline, with the education and training of her officers and men as the means by which the ship is controlled and directed, but it is *esprit de corps* which furnishes the breath of life. If we keep this fact before our eyes, realizing that as a man is measured by his desires and aspirations, so, in a ship, her general tone is the index of her efficiency, we cannot fail to practice and to preach the doctrine which it has been the intention of this paper to expound.

We shall surely have our reward. It may be in the correction

* This was written nearly a year ago.

of some of the many irregularities and anomalies which bear upon us hardly at times, and for whose adjustment mutual confidence and a readiness to sink self for the good of all are prerequisite. This much, at least, is certain, no relief to the body of officers and no general improvement of the service as a whole can be obtained so long as individual interests are fostered at the expense of the Navy at large, and so long as *esprit de corps* is regarded as of antiquarian or transcendental interest rather than recognized and proclaimed as a living and compelling force, the only bond by which to unite all the members of the naval profession, whatever be their rank or corps, in a homogeneous body of faithful, loyal and patriotic servants.

And doing this we shall likewise gain the right to use the stirring words of Nelson when asked by Lord Barham to select his own officers: "Choose yourself, my lord; the same spirit actuates the whole profession; you cannot choose wrong."

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE DEVELOPMENT OF SMOKELESS POWDER.

BY LIEUTENANT JOHN B. BERNADOU, U. S. N.

[Continued from No. 83.]

It was stated in the preceding paper that the ballistic effect produced by a progressive explosive depended directly upon the volume of gas it evolved upon combustion, but was not directly dependent upon the attainment of complete combustion. Assuming total conversion from solids into gases and non-liability to detonation, pyro-cellulose was shown to be the form of nitro-cellulose best adapted for conversion into smokeless powder. As this material contains only enough oxygen to convert its carbon into carbonic oxide, CO—less than gun-cotton, which converts its carbon partly into carbonic acid gas, CO₂, and partly into carbonic oxide, CO—the attainment of maximum efficiency from nitro-cellulose was thus shown to be accomplished through a reduction from a maximum to a mean in the amount of oxygen capable of being incorporated into nitro-cellulose.

On the other hand, it was stated that the incorporation of certain amounts of oxygen carriers (nitro-substitution compounds other than nitro-celluloses, such as nitro-glycerine and nitrates of metallic bases) into colloid nitro-cellulose led to the attainment of an increase in initial velocity of projectile for a given developed bore pressure. As nitro-glycerine furnishes a surplus of free oxygen to aid in completing the combustion of the gases from the nitro-cellulose, while the nitrates surrender oxygen on application of heat, it would appear in this case that the attainment of a more complete combustion led to improvement in ballistic effect.

We are thus brought face to face with a seeming contradiction—how, on the one hand, we must remove oxygen; how, on the other, we must add oxygen to a progressive explosive, in order to obtain maximum ballistic effect therefrom. In order to reconcile these apparently contradictory statements we must consider the manner of decomposition of the explosive in both cases.

One chief characteristic of pyro-cellulose is its homogeneity. It represents no mixture of explosives and combustibles, such as are presented by other forms of powders, and it is converted directly by combustion into a set of gaseous decomposition products that may not be varied in amount and kind. Under these conditions the ballistic effect of the expanding gases from pyro-cellulose may be referred to amount of charge, area of ignition surface, weight of projectile, caliber of gun, and volume of powder chamber. Other conditions affecting developed pressure and velocity are bore friction and resistance of the projectile to rotation through inertia.

The gun may be regarded as a gas engine in which the walls of the chamber and bore form the cylinder; the projectile, the piston. The expanding powder gases perform work by imparting velocity to the projectile, whose inertia they overcome just as gas by its expansion in the cylinder overcomes the inertia of the piston and the parts linked thereto. In the engine the gas is admitted alternately, first at one end of the cylinder and then at the other; in the gun it is admitted in rear of the projectile but once, so that the gun is an engine of a single stroke. In the engine the steam is admitted into the cylinder through a valve, and, after the lapse of a period of time less than that required for a full stroke, admission is cut off and work for the rest of the stroke is performed expansively; in the gun the charge of powder constitutes both the gas itself and the valve that admits the gas. For each grain of powder may be considered as a notch of opening of a valve; the more grains there are the greater the ignition surface, the greater the rate of emission of gas, or the greater the number of notches the valve is open.

The action of nitro-cellulose powder gases in imparting motion to the projectile is that of the gas in the engine cylinder. The decomposition products are evolved at a high pressure and act to propel the projectile, just as the gas or vapor drives the piston in an engine. Thus far the two cases are in parallel; they differ

in that the space occupied by the gas in the gun is constantly increasing, both through the effect of the motion of the projectile along the bore and from the increase of chamber space due to the melting away of the powder charge, while space in the engine cylinder is increased through the motion of the piston and through connection with the valve before cut-off. As shown in Table I, the ballistic value of gun-cotton colloided in acetone (for a given gun) was $\frac{2100}{16-19}$; that of colloided soluble nitro-cellulose, containing not enough oxygen to convert its carbon wholly into carbonic oxide, CO, was 2480 . Under similar conditions of firing, pyro-cellulose developed a value of $V/P=2490$. It may be urged that the ballistic superiority of the latter colloid as compared to the two former is not wholly attributable to character and amount of evolved gases, as the acetone colloid is brittle, and that prepared from soluble nitro-cellulose is somewhat brittle and is deficient in oxygen, while pyro-celluloid is of a tough, leathery consistency, capable of withstanding high pressures without premature disintegration. Nevertheless, as these colloids prove inferior to the pyro-colloids for lower pressures of about 10 tons per square inch, at which the effects of brittleness are not perceptible, and for which they all afford pressures regularly proportional to developed velocities, it remains that magnitude of volume of evolved gases is a factor of prime importance in the attainment of ballistic efficiency.

COMPOSITE POWDERS.

The results of incorporating an oxidizing agent or oxygen carrier into colloids merit special study. Suppose that a given nitro-cellulose be colloided and formed into strips of a number of definite thicknesses. If these strips be collected separately and dried, we may prepare from them series of rounds, each series composed of different weights of strips of some one thickness. If the length and breadth of the strips be great in relation to their thickness, we need consider only the latter element of dimension in relation to their mode of combustion.*

* We have (Glennon, Interior Ballistics, chap. VI, pp. 59-60)

$$\phi(\gamma) = \sigma\gamma(1 - \lambda\gamma + \mu\gamma^2 \dots),$$

where γ is the fractional part of the least dimension of the grain burned up to any moment; $\phi(\gamma)$, the fractional part of the whole grain burned up to

Upon firing series of rounds of the several powders from a given gun we obtain the following results as to their manner of explosive action:

1. Strips of over a certain mean thickness will be only partly consumed in the bore; the unconsumed remnants will be projected burning from the gun, to be quenched in the cool outer air, where they fall unconsumed to the ground and may be picked up at various distances from the piece in front of the muzzle, possessing the original form (in reduced dimensions) of the grains of which the charge was originally composed. Such powders develop low bore pressures and afford low muzzle velocities. In point of work performed they are equivalent to smaller charges of quicker powders. It may be remarked that no work is done in raising the temperature of the unconsumed portions of the grains, for if the temperature of the latter be raised but a few degrees, the ignition point of the explosive is reached and its substance would wholly disappear.

2. Strips of under a certain mean thickness are totally consumed in the gun. They develop high pressures for low velocities. The thinner the strips the less the weight of charge required to develop the limiting permissible pressure, on account of the greater initial surface presented by the thinner strips, which occasions a high initial gas development.

3. A certain mean thickness of strip will be found, for which, at a set limit of pressure, a minimum weight of powder will develop the greatest velocity that can be developed at that pressure. If strips of other thicknesses develop practically identical velocities and pressures for the same pressure limits, it will be by

the same moment; and a , γ and μ , constants depending upon the form of the grain.

If the grain be a rectangular parallelepiped with a square base, and the altitude as the least dimension, we have

$$a = 1 + 2x, \quad \lambda = \frac{2x + x^2}{1 + 2x}, \quad \mu = \frac{x^2}{1 + 2x},$$

where x is the ratio of the altitude to the side of the base."

Applying the above to the present case we find that if the altitude be considerably diminished (x approaches zero) we have the case of the thin plate; and that the constants approach the values

$$a = 1, \quad \lambda = 0, \quad \mu = 0,$$

or $\phi(\gamma) = \gamma$.

But γ depends alone on the thickness of the plate, therefore the speed of combustion of a plate is a linear function of its least dimension.

burning greater weights of powder. Such a powder may be designated a maximum powder, for the material from which it is prepared and for the gun from which it is fired.

Suppose, then, that colloided gun-cotton of nitration $N = 13.3$ develops in a given gun a maximum value $V/P = 2180$, what will be the effect of incorporating into such powder a certain amount of nitro-glycerine, or of metallic nitrates such as barium and potassium nitrates? Assume that during the process of colloiding the requisite amount of nitrates be uniformly incorporated throughout the substance of the pasty mass, which is subsequently formed into strips, as before. For this material we shall find that the maximum powder develops a value of $V/P = 2480$, as against 2180 for the pure colloid, a gain in velocity of 300 ft. sec. for a given pressure; in energy, $\left(\frac{mv^2}{2g}\right)$, of about 30 per cent.

If, in lieu of nitrates, we incorporate nitro-glycerine into the colloid, we will obtain a pasty mass that can be worked conveniently into the form of rods or cords, whence the name Cordite, applied to one of its best known types. Cordite, as used in England, consists of

Nitro-glycerine	58 parts.
Gun-cotton	37 parts.
Vaseline	5 parts.

Such a powder, fired under the above conditions, develops a value of $V/P = 2480$ approx.

There is one characteristic of powders containing nitrates such as the K and the French BN, to which attention is to be directed. The nitrates contained in these powders exist in them in a state of suspension; in an undissolved state. For the BN the microscope reveals minute crystalline particles uniformly disseminated throughout its mass; the barium nitrate employed in the K powder is insoluble in the colloiding agent, acetone, and is also insoluble in the colloid, in which it is held in a state of suspension and of uniform distribution.

In the case of the nitro-glycerine powders it is known that the nitro-cellulose is not in true solution in the nitro-glycerine. In this connection the following quotation from an authority upon nitro-glycerine powders, Mr. Hudson Maxim, may be cited:

"In the very early smokeless powders, especially those made of compounds of soluble pyroxylin (gun-cotton) and nitro-gly-

cerine, it was supposed that the nitro-glycerine actually held and retained the pyroxylin in solution, but it has since been learned that the nitro-glycerine is held by smokeless powders, whether made from high or from low grade gun-cottons, in much the same manner as water is held by a sponge; in fact, the pyroxylin exists in smokeless powders in the shape of a very minute spongy substance, and the nitro-glycerine is held in a free state within the pores of this sponge."

"It is possible even with powders containing as little as 25 per cent. of nitro-glycerine, to squeeze out the nitro-glycerine in a pure state by subjecting a piece of this powder to great pressure between smooth steel plates."

The amount of nitro-carrier (nitrate or nitro-substitution compound other than nitro-cellulose) considered necessary to the production of good ballistic results, as exemplified in certain known powders, may be tabulated as follows:

TABLE III.

Variety of powder.	Nitro-carrier used.	Per cent. of nitro-carrier in given weight of powder.
Cordite.	Nitro-glycerine.	58
Maxim.	Nitro-glycerine.	10 to 25
BN.	Barium and potassium nitrate.	21 to 25
K.	Barium nitrate.	14.25

The composition and ballistic properties of the three classes of explosives—pure colloids, colloids containing metallic nitrates, and colloids containing nitro-glycerine—may be compared as follows:

TABLE IV.

Variety.	Pure colloid.	K.	BN.	Cordite.
	Gun-cotton, 85.00	Gun cotton and soluble nitro-cellulose, balanced } 84.25	Insol. nitro-cellulose, 38.67	Nitro-glycerine, 58
	Soluble nitro-cellulose, 10.00		Soluble nitro-cellulose, 33.23	Gun-cotton, 37
	Sodium carb. 1.00		Barium nitrate, 18.74	Vaseline, 5
	Solvent, resins, &c. 4.00	Barium nitrate, 14.25	Potassium nitrate, 4.54	100
	100.00	Calc. carb. 1.50	Cal. carb. 3.65	
		100.00	Volatile, 1.29	
			100.12	

TABLE IV.—*Continued.*

Type.	Pure colloid.	Metallic nitrate.	Metallic nitrate.	Nitro-glycerine.
Manner of incorporation of oxygen carrier.		Solid undissolved particles, uniformly distributed throughout colloid matrix.	Solid undissolved particles, uniformly distributed throughout colloid matrix.	Undissolved particles held in suspension as water in sponge.
$\frac{V}{P}$	$\frac{2100}{15-19}$	$\frac{2400}{15}$	$\frac{2400}{15}$	$\frac{2400}{15}$

Remembering what has been said in relation to the ballistic performance of the varieties of powders cited, we are led to the following conclusion:

That minute particles of an oxygen carrier uniformly incorporated into a nitro-colloid and held in suspension in an undissolved state throughout the body of the same, render more progressive the combustion of the nitro-colloid into which they are incorporated.

For convenience of reference I shall refer hereafter to the oxygen carrier held in suspension in the colloid as the *accelerator*.

Viewed in the light of the principle here enunciated, the several powders that we have been considering are all similar variants of the pure colloid. The remark of the compounder, "that a little nitro-glycerine certainly does help the powder along," is now the more readily comprehensible.

The methods commonly employed for co-ordinating natural species may be applied, by way of illustration, to the classification of the various types of progressive explosives, to establish their relations to one another, and to indicate the lines along which advances have been effected.

TABLE V.

Family.	PROGRESSIVE EXPLOSIVES.									
	Agglomerated Powders.			Pure colloids.			Accelerated colloids.			Classification letter.
	Blk. gun-powder.	Brown powder.	Acetone colloids (experimental; for small arms).	Pyro-cel-lulose. United States; Russia, France.	Acetic ether col-loid. Wette-ren.	Ether-alcohol, with or without insoluble nitro-celluloses incor-porated.	Acetone col-loid; nitro-gly-cerine ac-celerator.	Acetone col-loid of blended ni-tro-cel-lulose; bari-um nitrate ac-celerator.	Ether-alco-hol col-loid; barium ni-trate and potassium nitrate ac-celerator.	
Sub-spe-cies.	Various mixtures of char-coal, saltpetre and sul-phur.	Various mixtures of char-coal, (partly charred and con-taining oxygen), saltpetre and sul-phur.	Colloids of insol-uble and soluble nitro-cel-luloses.	Poudre B: France.*	Gun-cot-ton, with or with-out sol-uble ni-tro-cel-lulose.	From nitro-cellu-lose. From nitro-hydro-cellu-loses.	Various propor-tions of ni-tro-glyce-rine in ni-tro-cel-lulose.	Various pro- portions of nitro-cel-lulose and nitrates.	Various pro- portions of nitro-cel-lulose and nitrates.	Rifflite; nitro-cellulose col-loided in acetone, with or without di-nitro-benzol.
	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.

* The first rational smokeless powder; developed in France by the eminent savant M. Vieille.

We shall next consider how the accelerator acts to develop increased velocity without developing increased pressure.

1. It has already been shown how it is possible with powders containing as little as 25 per cent. of nitro-glycerine to squeeze out the nitro-glycerine in a pure state by subjecting the powder to great pressure between smooth steel plates.

If it be possible to extract nitro-glycerine by application of pressure from powder in which it is incorporated, then there will be a tendency to flow in the direction of least pressure from the instant of ignition of a charge to that of its complete combustion. This would mean, first, flow from within outwards in the gun chamber, where a relatively large proportion of the nitro-glycerine would be consumed; second, flow in the direction of the windage, where the amount of nitro-glycerine consumed would also be relatively great. Such action accounts for the rapid erosion of the surfaces of gun chamber and rifled bore when powders containing nitro-glycerine are employed.

2. The eminent Russian chemist, Professor D. Mendeléef, developer of smokeless powder in Russia, in a paper upon pyro-cellulose powder, says:

"The chemical homogeneity of pyro-collodion plays an important part in its combustion, for there are many reasons for believing that upon the combustion of those physically but not chemically homogeneous materials, such as nitro-glycerine powder (ballastite, cordite, etc.), the nitro-glycerine is decomposed first, and the nitro-cellulose subsequently in a different layer of the powder. The experiments of Messrs. T. M. and P. M. Tchelstov at the Scientific and Technical Laboratory show that for a given density of loading the composition of the gases evolved by nitro-glycerine powders varies according to the surface area of the grains (thickness of strip), a phenomenon not to be observed in the combustion of the pyro-cellulose powders. There is only one explanation for this, viz., that the nitro-glycerine, which possesses the higher rate of combustion (Berthelot), is decomposed sooner than the nitro-cellulose dissolved in it. This is the reason why nitro-glycerine powders destroy the inner surfaces of gun chambers with such rapidity."

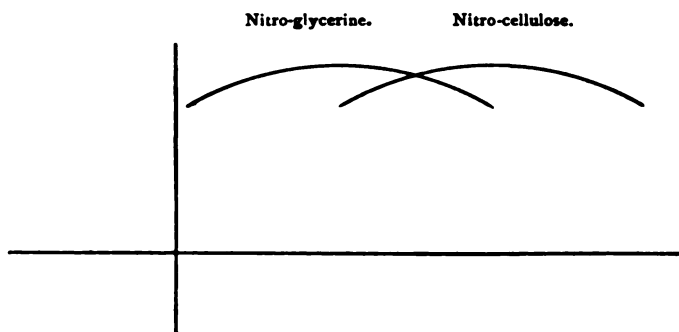
We conclude from the above that the nitro-glycerine incorporated into a colloid burns more rapidly than the nitro-cellulose forming the colloid. More nitro-glycerine is consumed with

one part of the charge than with another. During the first period the products of combustion evolved in chamber and bore are largely those of nitro-glycerine; during the second, those of nitro-cellulose.

Moreover, as both materials exist in an uncombined state, although in one of intimate admixture; as both decompose wholly into gases, while each contains sufficient energy to continue its own decomposition, once that decomposition is begun, there is no reason why the rates of the two decompositions should be equal; it would rather appear that each substance should decompose at the rate peculiar to itself, as far as it was able, under existing conditions of heat and pressure, to effect a separation of its substance from the mixed mass of the powder.

Conditions point, therefore, to there being two intervals in the decomposition of the charge, during one of which a maximum amount of nitro-glycerine, and, during another, a maximum amount of nitro-cellulose is burning.

In what follows it is not intended to attempt more than to indicate mode of progressive combustion as implying the superimposition of maxima and minima of effort. This may be represented graphically in the present case as follows:



The result of the combination of the conditions here indicated would be the imparting of a double impulse to the projectiles due to the successive occurrence of two maxima of acceleration. Considered as to their limit of possible range, the successive impulses may occur incrementally, so that the accelerator may be expressed in the form

$$\varphi(p') \frac{d^2 p'}{dt^2} + \varphi(p'') \frac{d^2 p''}{dt^2},$$

where p' represents the pressure due at any instant to the combustion of the nitro-glycerine; p'' , that due to the nitro-cellulose.

The projectile may be regarded as receiving a third impulse, resulting from the chemical combination of the gases evolved by the nitro-glycerine and the nitro-cellulose. According to the researches of Messrs. Macnab and Ristori (Proc. Royal Soc., vol. LVI, p. 8), the decomposition products of nitro-glycerine are

CO ₂	CO	CH ₄	O	H	N	H ₂ O
57.6	—	—	2.7	—	18.8	20.7

And from the same source we obtain the decomposition products of nitro-cellulose ($N = 13.3$) as

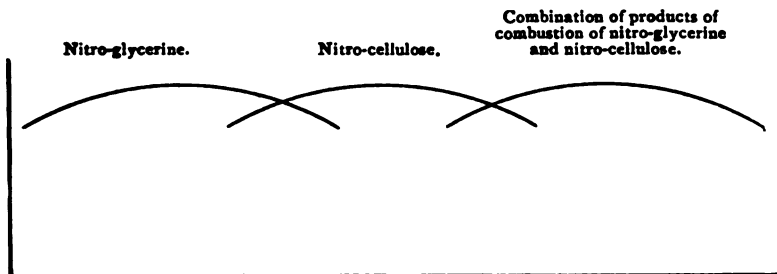
CO ₂	CO	CH ₄	O	H	N	H ₂ O
29.27	38.52	0.24	—	0.86	13.6	16.3

What may be called the third impulse would represent the combination at a high temperature of multiples of decomposition products developed in the ratios

$$A \left[\begin{array}{cccccc} \text{CO}_2 & \text{CO} & \text{CH}_4 & \text{O} & \text{H} & \text{N} & \text{H}_2\text{O} \\ 57.6 & - & - & 2.7 & - & 18.8 & 20.7 \end{array} \right]$$

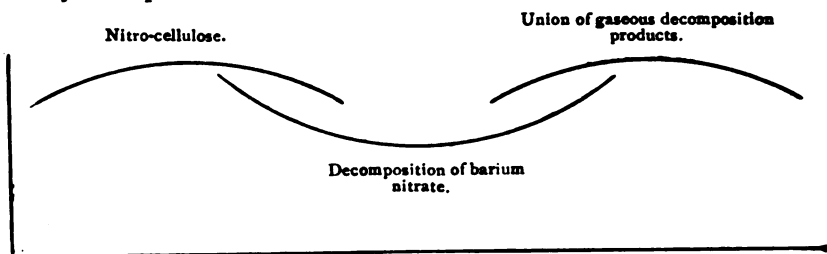
$$B \begin{bmatrix} 29.27 & 38.52 & 0.24 & - & 0.86 & 13.6 & 16.3 \end{bmatrix}$$

These phases may be indicated graphically as follows:



Accelerated colloids of K and BN types containing metallic nitrates are next to be considered. We may assume that the nitro-colloid into which minute particles of a nitro-carrier of this type are cemented itself burns in approximation to the law of decomposition of the colloid. This state of affairs is similar to, though not identical with, the preceding; in the former, both nitro-glycerine and nitro-cellulose are able to effect their own decom-

position, evolving gases that recombine; in the latter, the nitro-cellulose alone possesses this property, the metallic nitrates surrendering their oxygen through the effect of heat developed during decomposition of the colloid. The successive reactions may be represented as follows:



Instead of three maxima of effort there are two maxima and one minimum, the maxima representing the combustion of the nitro-cellulose and the subsequent combination of the gases therefrom with the oxygen of the barium nitrate; the minimum, the absorption of heat expended in decomposition of the barium nitrate.

A comparison of the diagrams shows that the processes of combustion in the case of colloids containing nitro-glycerine and of those containing metallic nitrates are similar. Both represent aggregates of work resulting from successions of independent decompositions. For such powders an element of time enters into our conception of chemical action; what the ultimate products of combustion are depends upon the order of occurrence of successive evolutions of various volumes of different gases at high temperatures.*

The base of the projectile is subjected to a series of impulses due to the development of successive waves of pressure; the result is an increased initial velocity for a given developed pressure, the acceleration being sustained throughout a comparatively longer period of time.

Those familiar with experimental development of ordnance during recent years remember a type of multi-charge gun whose construction seemed based upon a favorable combination of correct principles, but which was rejected on trial, as its practical

* See extracts from paper by Prof. Mendeléef, p. 33.

disadvantages were found to outweigh by far its advantages. I refer to the Lyman-Haskell multi-charge gun, a weapon supplied with a number of pockets distributed along the axis of the bore. In each pocket a charge of powder was placed; it was supposed that the projectile, by uncovering successive pockets in its flight, would cause their contents to ignite and thus furnish successive accelerating impulses to increase its velocity.

From what has been already said in relation to the principle of successive combustion, it will be seen that the employment of charges of accelerated powder, like those above described, in a gun of present day type, represents the limiting extension of the multi-charge principle. In relation to their successive combustions, the nitro-glycerine and the nitro-cellulose may be considered as sub-charges, contained in independent chambers or pockets, or distributed throughout a very large number of small pockets.

The principle already stated, as established by the study of the ballistic action of accelerated or composite powders, may be now amplified as follows:

Minute particles of an oxygen carrier, uniformly incorporated into a nitro-colloid and held in suspension throughout the mass of the colloid in an undissolved state, act through their independent combustion in such a manner as to render more progressive the combustion of the colloid into which they are incorporated.



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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

HONORABLE MENTION, 1898.

MOTTO: What boots it at one gate to make defense,
And at another to let in the foe?—*Milton.*

OUR NAVAL POWER.

By Lieutenant-Commander RICHARD WAINWRIGHT, U. S. Navy.

THE USES OF A NAVY IN TIME OF WAR.

The naval force of a country engaged in war will act either on the offensive or defensive, but in both cases its objective will be the fleet of the enemy. A portion of the force may be acting offensively against the enemy while another portion remains to defend the coast. The stronger force will generally seek the enemy's fleet near his coast, while the weaker force will remain near home ports, so as to utilize the advantages of short lines of communications, repair shops, supply depots and coast fortifications.

The stronger force will endeavor to obtain "command of the sea," and after that, utilize this command by invading the enemy's country, blockading his ports and destroying his mercantile marine, endeavoring to bring the war to a successful ending by seizing his territory and destroying his commerce; while the weaker fleet will dispute the "command of the sea," and will endeavor, by taking advantage of the mistakes or misfortunes of the enemy, to defeat him and, if possible, to turn the tables upon him and seize the "command of the sea" with all its attendant advantages.

Every country must look to its "sea power," not only to defend its coasts, but also to protect all its interest beyond its coast; and every civilized, and many uncivilized, countries have extended and varied interests all over the world. No country can be a great maritime nation without adequate sea power. It may have a large commerce without a large merchant marine; but such foreign commerce carried on in foreign bottoms will never expand to its proper dimensions unless aided by its own merchant marine and protected by its own navy.

THE SEA POWER REQUIRED BY THE UNITED STATES BECAUSE OF ITS GEOGRAPHICAL AND POLITICAL SITUATION.

Those who advocate placing the country in a state of "preparedness for war" are often called "jingo" by those who advocate peace at any price; and when told that the surest way to prevent war is to be prepared against all comers, they then erect their crests in a warlike and, what they believe to be, a patriotic manner, and loudly assert that no one will dare attack this country with its immense resources. They then point to the wonders that have been accomplished in former wars. Without endeavoring to point out where we failed, and what immense sacrifices we were forced to make when we succeeded, for want of being prepared for war, it should only be necessary to show how in modern times, as never before, time is a great element, and that all our immense resources, money, wealth and ingenuity, would be unable to create a respectable sea power within the ordinary limits of a modern war. Dilke and Wilkinson, in their "Imperial Defense," say: "The suffering entailed on men by every international conflict, the suspicion that wars have too often been entered upon without justification or without a clear understanding of the purposes to be served by them, and the growth of a human sympathy which rightly shrinks from every form of violence, have given rise to a widespread feeling that war is wicked in itself and might perhaps, by political arrangement, be rendered unnecessary. Many of our countrymen, accordingly, abstain from all enquiry into the principles of naval and military administration, believing that the discussion of these questions promotes the growth of a militant disposition and thereby increase the evil which they wish to avoid." Not only is this feeling widespread in the United States, but

also one that its immense resources are a protection in themselves. When did a policeman or a police force serve to create lawlessness? Would a court be effective without its officers to enforce its mandates? The idea of arbitration is undoubtedly one suitable to civilized nations and would serve to diminish the risks of war between mutually respecting countries; but there must be mutual respect backed by a reasonable show of power to enforce respect, the policeman must carry his club, until political and personal morals have progressed far beyond their present condition. Great Britain meant well with her arbitration treaty, but she did not offer to cede Bermuda to the United States.

The geographical position of the United States is one that plainly indicates the necessity of efficient armed forces to protect its extended frontiers, so long as political morality requires strength to protect wealth. North and south its frontiers are partly land and partly water, but on both the east and the west they are water.

Invasion by land can be resisted only by land forces. Invasion by sea may be resisted partially by land forces; but it is an imperfect and expensive way, and an invasion by sea should be met by sea forces. Moreover, in all countries bordering on the water, their borders are extended into the sea in proportion to their commercial interests, and these sea rights and interests can be protected only by sea forces.

At the present time our land frontiers are bordered by states comparatively weak in military strength, and it would be madness for them to attempt invasion while our small army is maintained at its present strength and efficiency. Of course, to disband or to materially reduce our army would be to invite border raids, if not to permit serious invasion.

Our eastern frontier is open to the attack of the great navies of the world; so is our western, only to a less degree, as it is more distant from their permanent bases. The first question to consider is, how far into the sea do our interests extend? At the present time we have a large foreign and coastwise trade, with a very small amount of tonnage engaged in the foreign trade and a very large tonnage engaged in the coastwise trade. Our interests at present do not demand protection far from our shores, and our citizens only require protection abroad when in

uncivilized countries. If our coast trade routes were well protected and our seaports kept free for ingress and egress, our interests beyond our shore would be well guarded. Still our interests have extended and our vessels have navigated to all parts of the world, and will do so again if our country continues to grow in prosperity and power. Then the trade routes must be protected and our commerce rendered secure along the line as well as at both extremities.

All history shows that great states do not remain long at a standstill. There is a rise and a fall among the great nations in their struggle for existence, more or less regular and constantly moving in one direction or the other. Our country must expand in its growth, extend its interests and continue to rise, or it will contract, diminish its interests and commence to fall from its great height. The struggle for existence in nations, like that in individuals, is ceaseless, vigorous and relentless. The law of the survival of the fittest is as true for the political aggregation as for the individual. Much has been written on the decline, in fact almost complete annihilation, of our merchant marine engaged in the foreign carrying trade. Before the war our vessels engaged in the foreign carrying trade were numerous. The effect of the war was to greatly diminish their numbers. Vessels destroyed by privateers, vessels whitewashed, hoisting another flag, and vessels laid up because those of other nations had seized their lines of trade, formed together by far the larger portion of our merchant marine. At this time came the change from sails to steam as a motive power, and from wood to iron and steel as a material for hulls. We were prevented by the war from keeping abreast of the improvements, and the conclusion of the war found us behind in the race. Our navigation laws were such as to discourage capitalists from going into the foreign trade under our own flag. But the most potent factor of all was the change in the condition of the internal communications that took place about the end of the war. Before the war, rivers and canals formed the principal routes for moving internal commerce; but after the war an impetus was given to railroad construction. Then both capital and labor found ample scope in developing the internal sources of wealth of the country, and better returns were promised than could be obtained by developing our foreign commerce and carrying trade.

Formerly the internal development was confined to a comparatively small strip of the country, and following natural laws, capital sought larger returns by developing foreign commerce; but with the spread of the railroads capital found ample employment in the development of internal commerce, and room was found for large quantities of foreign wealth, and our foreign trade moved along slowly, our foreign carrying trade ceased to exist. But there are signs showing that the quick returns and big profits reaped by capital in internal development are no longer easily obtained. There is still ample room for small profits due to steady development, but the speculative mind must turn once more to the increase of our foreign trade. We are now passing through a period of financial depression, and many nostrums are offered as sure cures to the public. Some would have free silver, others would withdraw the greenbacks, and others would have a higher tariff. In the meantime there is plenty of money ready to invest, but there is lack of confidence in the investments offered. Whether or no confidence returns with the passage of the tariff bill, when it does return, money will begin to find its way into foreign commerce, for it is certain that our farms and factories produce more than we can consume or export without new markets, and the glutted markets have reacted on each other. With new markets for our manufactures, the operators can afford to consume more products of the farm, and with new markets for the farm produce, the farmers can afford to use more manufactured articles. So that new markets are the road to wealth, and we must seek new markets in our own merchant vessels.

We must begin to seek our share in the new parts of China that are now about to be thrown open to the world, as is foreshadowed by the opening of West River in the south and the calling for bids for many tons of steel rails in the north. We must strengthen our trade with Japan, we must seek for a market in all portions of the globe; but above all we must develop our commerce with Mexico, Central and South America. Then we must have our own ships, for the competition in the commercial world is excessive, and the best markets go with the carrying trade. Once again our flag will be flown in all portions of the world, the protection of the navy must be extended far beyond our shore, and we must have command of

the Caribbean Sea. To other nations it may be as the Mediterranean is to Europe, but to us it must be as the Irish Sea is to Great Britain.

The policy of our country is not an aggressive one, we only require armed forces for the protection of our country and its interests. At present the protection of our coastwise commerce and the sea-coast is all we are called upon to undertake; but with our extended coast-line this is a large, if necessary, undertaking. To insure its safety against the strongest maritime power, Great Britain, will be to insure it against any probable combination of other powers. The most complete security is obtained by being sufficiently powerful to carry the attack to the coasts of the enemy; but with the immense sea forces of Great Britain such a measure of protection would strain the resources of our country, would tend to disturb our peaceful policy, and is certainly beyond the views of our most enlightened legislators, and therefore impossible of realization. Even with our present weak army, embryo navy and defenseless ports, there are many who assert we have nothing to fear from foreign nations. Not only do they prevent advance or increase, but they deprecate even expenditures necessary to maintain the little that we have in a reasonable state of efficiency. Yet there are some few who realize that we are a great nation, whose interests and affairs are so closely interwoven with those of other nations as to preclude us from remaining isolated in the political world, however anxious we may be to avoid the responsibilities attaching to our international position. There are a few who realize that while our resources are immense, we are unprepared for war, unprepared to assume the responsibilities forced upon us by our greatness. Some few who realize that millions of men unarmed are no better than a flock of sheep; undrilled, no better than a mob; and that a great and wealthy nation unprotected is but a temptation to others well prepared, and when that nation becomes aggressive in its attitude the temptation becomes irresistible.

Some few would see our country prepared for war as the best means to insure peace; and should war come, to insure against the evil results consequent upon a want of preparation. Some few, who would fortify our ports, strengthen our army sufficiently to man the fortifications without depleting the mobile force; and

above all, would build up our navy, without which fortifications and armies would be powerless to protect our coast. Some few, very few, would even recognize the necessity of accepting coal-ing stations dominating our coasts and ready to fall into our hands.

Many see the advantages of the Nicaragua Canal, but while recognizing the commercial gain, fail to see the greatly increased political responsibilities. The gains are well worth the risk, but unless the dangers are properly met the gains will prove illusive.

Few there are whose bosoms failed to swell with pride at the re-announcement, by the last administration, of the great American policy sometime called the Monroe Doctrine—an old policy somewhat enlarged to fit new conditions and new responsibilities, but still the true American doctrine of America for Americans—a doctrine recognizing that the strong United States is responsible for the protection of the weaker American states; that its true interests require it to extend its sheltering arm over them and to see that their people are free to follow her towards a higher civilization and a greater prosperity.

Is it not necessary to secure our possessions at home before we can hope to render secure those of other American states? We should not be over-confident because of the success of our last effort to enforce the Monroe Doctrine. We were then reasoning with a free people, accustomed to deliberate, loving fair play, with interest bound up in our own, and with many entanglements threatening. They preferred arbitration to war; but we must remember that sometimes it may require persuasion backed by force to carry out the decisions of the arbitrator. Some there are who would rely on our great wealth and large resources, but should their policy rule they will surely find that the resources will come into play too late and the wealth will be sacrificed to their error. Some would narrow and confine all commerce within the United States, would keep our citizens at home, sell and receive goods only at our own ports, and sympathize distantly with the ills of other nations. These may dam up our commerce for a time, but it must overflow all artificial barriers and spread in streams radiating in all directions. Steam and electricity have bound the world in too narrow a compass for even China to remain shut out from the family of

nations. Loss of money through pestilence in India is felt in the pockets of the farmer in Illinois, and part of the war indemnity paid by China comes from the pockets of the manufacturer in Manchester. The peace at any price, without honor and with shame party will feel war, when it does come, and it surely will come, where it is most sensitive, in its pocket. Men insure their lives and their property, and insure against every ill that man inherits. Why not insure against the evils of war? Let us command peace, and if war comes, command a speedy return to peace. Let us have a military power, both sea and land, such as will command respect and will insure the safety of our citizens in life, liberty and property in any and every portion of the globe.

THE LINE DRAWN BETWEEN THE MOBILE AND IMMOBILE DEFENSES OF OUR COASTS.

Before outlining the work to be performed by the sea forces and showing of what classes of vessel they should consist, it is necessary to show where the line should be drawn between the work to be performed by the land forces and that by the sea forces, as well as the line between the mobile and immobile defenses, both land and sea.

The immobile defenses of a harbor or coast include the fortifications with their armament and the mines and other obstructions. The mobile defenses consist of the army, that part not confined to any fortress; and the fleet. All nations are limited in their defenses by their cost or the amount of money available for such purposes, so that in order to have the best defense for the money allotted it becomes necessary to carefully consider the amount to be devoted to any one position or for any particular object. The greatest difficulty in making a wise disposition of the available funds is encountered when considering the points where the functions of the mobile and immobile defenses overlap. It is therefore necessary to consider carefully the function of each class of the defenses in order to draw the dividing line.

It must be evident to all that there can be but few harbors or positions on or near a coast that cannot be rendered impregnable by immobile defenses against all possible attack. But while some of these can be defended with comparatively small expenditure, many of them could be rendered impregnable only

after the expenditure of very large sums of money. Also that such a naval force could be created that it would prevent any likelihood of an attack. Not only would such a force be beyond the calculations of any nation, but also quite a large portion of it must be so confined to particular localities as to largely partake of the nature of immobile defenses. The cost of mounting guns on ships, the cost of the ship being included, is very large in proportion to that of mounting guns in fortifications, the cost of the fortifications being also included. But the effective radius of the gun is limited on shore to its range and arc of fire, while that of the gun afloat is only limited by the power to renew the supply of fuel for the vessel. The amount of protection that can be given to the guns on shore and to the men who serve them is practically unlimited, while the protection that can be given on a vessel is closely limited by numerous conditions. Again, immobile defense can be used only on the defensive, whereas a naval force is at its best when employed in offensive operations.

The correct solution of the problem of dividing the expenditures between the mobile and immobile defenses so as to obtain the most secure defense requires that the peculiar properties of each kind of defense should be developed to the uttermost.

There is quite a difference between applying this rule to the defense of Great Britain and to applying it to the United States. The naval strength of the former so far exceeds the requirements of mere coast defense that the amount of immobile defenses can be considerably diminished, whereas the United States can only hope for a fleet sufficient to protect when proper advantage is taken of the fortifications. The policy of this country does not permit the building of great fleets, and it will be years before our naval force will be of sufficient size for an economical defense; but as our fortifications are in the same or even more backward state, the two should grow together, and by fully utilizing the peculiar advantages of each class of defense in its proper place, the most thorough and most economical protection of our harbors and of our coasts will be attained.

Immobile defenses, intended to provide against a sea attack, may be to defend a port, to strengthen a defensive or offensive line and to protect naval bases. The port may be of more or less importance strategically, according to its geographical,

political, naval, military and commercial value. Ports will vary among each other in all these particulars. In New York they all unite to make it the most important port from all points of view. Here the immobile defenses should be sufficient, with the aid of the mobile army, to resist any probable attack, even when our fleet was not able to assist. Admiral Colomb gives the following rule for the strength of immobile defenses: "The only point to secure is that the enemy shall not be allowed to believe he can succeed in completing any open conquest before the arrival of the defending mobile force." In the term "defending mobile force" he included both army and navy. With the navy of Great Britain, maintained as it is at present, sufficient in strength to cope successfully with that of any two of the great powers, there is little or no danger of her fleet being many hours behind that of her enemy, and her army has comparatively small distances to travel. But our fleet might be held elsewhere by a superior force for some little time.

Commercial ports must be defended in some proportion to their importance, which may be increased by their being also naval or military bases, and in direct proportion to the depth of water that can be carried within gunshot of them. When of small importance they only need such defenses as will keep off cruiser raids, and as their importance increases so does their danger from stronger attacks and consequent necessity for stronger defense; but it is in no case advisable to protect against battle-ships when there is insufficient water to allow these vessels to come within the range of their guns.

Advance naval bases should require such protection as is necessary to render the base safe against cruiser raids, or such light attacks as might be attempted during the temporary absence of the guarding fleet. The point is that if the guarding fleet were absent it would be in touch with the fleet of the enemy, so that he could not afford to send away large detachments. The bases may require still stronger protection if they should happen to be the only suitable bases for an enemy attacking that portion of the coast. Then they should be able to withstand an attack in force.

When the cost of the immobile defenses of a coast, including maintenance, approaches the cost of the probable fleet that any possible enemy could bring against it, then that coast can be

defended far more securely by maintaining a fleet of commensurate cost without immobile defenses. For it must be remembered that even when all points of importance have been well covered by immobile defenses, the very thing that has made these ports of importance, their communications, may be easily cut off. And while the shipping and some of the wealth may be safely locked up within fortresses, values will fade away and wealth be diminished because the communications have disappeared. Again, although these fortresses may protect the actual vicinity of the port, it would be impracticable, with an extended coast line, to defend all possible landing points; and without a defending fleet the enemy could transport his army freely from point to point, avoiding fortifications, and probably outstripping the mobile army of the defense.

On the other hand the mobile defenses can only give perfect protection by being confined to specific localities, and thus losing some of their mobility. The navy should form the main coast defense and the fortifications the main harbor defense. Even Great Britain would find it impossible to give adequate protection to her coasts, colonies, and trade routes and lines of communication by her navy alone. She might have "command of the sea" in the larger meaning of the term, but she would be without local command for a time at many points. Her great ports, arsenals and fortresses would prove well worth a raid in force, and are therefore well worth protecting by immobile defenses against such raids. Her coaling stations also need immobile defense, only she should be careful not to let the secondary object obscure the primary and forget that local command is a small thing in comparison with the "command of the sea," and that while local defenses may strengthen the sea power, they can never give the command of the sea.

A national scheme of immobile defenses will provide sufficient protection to the permanent naval bases to prevent their capture by the sea force of the enemy. As next in importance should come the naval lines of defense. The advance bases on the lines should be so protected as to prevent their being seized by raiders during the temporary absence of the mobile defenses. There may also be found on these lines certain points so situated tactically as to admit of their acting with the fleet. Such points are to be found at the Race on the Gardner's Bay-Fisher's Island line; and at the Tortugas, on the Key West-Tortugas line.

A naval line of defense, such as those named above, is chosen at points of sufficient strategical importance, where the surroundings, topographic and hydrographic, permit the fleet to concentrate in force, and contains one or more advance bases where the immediate supplies of the fleet are kept. The line should be so situated that the fleet under way can co-operate with the forts to resist the attack; that is, the shore defenses would be so placed that the defending fleet could not be attacked without coming within the range of a number of the guns, etc., of the fortifications; and this not with the fleet at anchor under the guns, but capable of manœuvring and concentrating at that point of the line attacked. Thus the advance bases would not be fortresses where the fleet could retire and be masked by the enemy's fleet, but an extended line of fortifications which must be forced in the face of the fleet. Thus the Race would partake somewhat of the nature of a defile or pass, with the adjoining hills crowned with guns, and the defending army drawn across the further end, ready to crush the heads of the columns as they emerge from the pass.

A small but active fleet could hold such a line against a much larger force, and by meeting the enemy on the line, would be far more likely to do more damage to the enemy and have more influence in thwarting his purposes than by attacks when issuing from some fortress.

With these naval lines well fortified, and with a fleet of reasonable dimensions, large portions of the coast can be protected and the coastwise commerce remain uninterrupted. With the Gardner's Bay-Fisher's Island line well fortified, a small active "fleet in being" can hold a very large fleet at bay, and can force the enemy to keep his fleet together, thus protecting other portions of the coast.

Finally comes the immobile defense necessary for commercial ports. This should be proportioned to their importance and to the attractions they present to an enemy inducing him to make an attack; and it should be closely limited by the depth of water in the channels, for a large number of our ports are already protected by nature from attacks by battle-ships, and it is a great waste of strength to mount heavy armor-piercing guns when armored ships draw too much water to approach within gun range of the port. In considering the amount of immobile de-

fenses to give to any one place, care must be taken not to exaggerate its importance. It is well to remember that while the property itself may be held safe, that its principal value may be destroyed by the enemy for as long a time as he can cut off all communication. It is at this point that the mobile defenses come into play, and it is the part of the fleet to prevent this interruption or to shorten its duration.

During the war of 1812 our ports were well fortified for that time. The British fleet made no impression upon our ports, but for want of a defending fleet our commercial losses were enormous, and the value of our commerce diminished from about \$250,000,000 to \$21,250,000.

General Abbot paid great attention to the subject of defending our coast, and has written and lectured frequently on the subject; but he entertained the same error as is held by many military men, viz. that it is the duty of the army to provide safe fortresses for our fleets whence they can sally at will to assume the defensive. They imagine some large harbor, strongly fortified, where a fleet can lie idle, safe from the attacks of the enemy until opportunity arises to sally forth and strike him at a disadvantage. This is a most dangerous fallacy; a passive fleet has little opportunity for observation. History is against the efficiency of an idle fleet, and while some of the manœuvres of modern times appear to show that it is not difficult for vessels to escape from a blockaded port, they must escape in small numbers at a time. A powerful enemy first seeks to find his foe, and next to meeting him and crushing him on the high seas, he desires to bottle him up in some port from which he cannot move without his motions being observed; and from many such ports he can only come out in a formation presenting a narrow front and thus giving his enemy the advantage of gun fire. The safe rendezvous should be a line with bases, where the immobile defenses can aid the weaker fleet in sustaining an attack and can hold secure the necessary supplies. Another fallacy held by General Abbot was that shore defenses could prevent distant bombardment; and Lieut. Weaver advocated 20-inch guns that would serve to keep vessels off at a distance of six miles. To the naval mind this seems absurd, and it looks as if both our own and English army officers have an exaggerated idea of the accuracy possible with modern high-powered guns. It is true

that with range and position finders and with telescopic sights the guns can be pointed with remarkable accuracy, and the errors of modern guns are comparatively small; yet when one remembers the very small angle subtended by the largest battle-ship at long ranges, it becomes evident that the chances of hitting such a ship at anchor, much less when moving, are very small. Even with the correct range and the gun accurately laid, the slightest inaccuracy in the projectile, or difference in the quality of powder, and the projectile will fly wide of the mark. When the movement of the vessel with the time of flight of the projectile is further taken into account, it would seem that guns are not formidable when firing at ships from a great distance. When the city is so situated as to permit the use of barrier forts at a distance, then permanent works will serve to forbid distant bombardment.

Coast defenses when applied to fortifications are generally misnomers. They are usually harbor defenses, and are only coast defenses when defending advance naval bases. The true coast defenses are the vessels of the fleet. It may be necessary to use some portion of the fleet to assist the fortifications in defending a harbor. In this use the mobile defenses most closely approach the immobile, and the best quality of the vessels, their mobility, is greatly restricted. Great care must be taken to prevent localizing the sea force more than is absolutely necessary. Floating batteries should never be used where their work can be performed as well by guns on shore. There are some harbors, like San Francisco, where guns on shore will not afford sufficient defense, then floating batteries must be used, and they become part of the local defense, losing much of their mobility. Picket launches are needed to guard the mines in foggy weather, when the rapid-fire batteries on shore might prove insufficient; and torpedo-boats would prove most valuable weapons. These latter, when not sea-going boats, should be attached to districts and not to special ports, so that their mobility can be developed as fully as possible.

It is apparent from the newspapers, from the speeches in Congress, and from the appropriations granted, that the people of the United States have become impressed with the necessity of a secure defense, and after years of very small or no appropriations for fortifications and guns, comparatively large appropriations

have been made and the entire engineer corps of the army has been at work on plans for our numerous harbors. There is a great element of strength in any scheme of land fortifications when striving for appropriations; each locality is deeply interested in the fortifications in its immediate vicinity, both because of the additional security and because of the money spent and labor employed. This serves to bring votes, and strong efforts are made to obtain and to increase appropriations for this object, so that there is danger of the fortification bill becoming like the river and harbor bill, where local interests are apt to be more potent than national necessities. Were the public purse unlimited this feature would not be objectionable from a naval or military point of view, but as the appropriations are closely scanned and the sum-total to be spent for defense confined within narrow limits, there is great danger that what is given to the immobile defenses may be taken from the mobile, and the Navy may be left without chance of increase, the real safety of our coast sacrificed, and the mobility of our army destroyed by being localized and scattered among numerous fortifications.

On the other hand it does not do to put too small an estimate on the value and power of land defenses when properly used. High angle firing will be freely used, and with modern B. L. mortars the accuracy, rapidity and efficiency of high angle fire have been increased greatly. Anchoring within 10,000 yards of one or more mortar batteries would be to invite destruction. Here the large number of shots fired serve to make up for the inaccuracies of pointing. Motion, including both change of speed and change of direction, would be necessary to enable a vessel to remain within range with any reasonable degree of safety. Mortars can be placed so as to be almost, if not entirely, safe from modern high-powered guns mounted on board ship. As far as security goes the same may be said of guns mounted on disappearing carriages, their emplacements can be well scattered and yet their fire controlled by one commander. The range-finder and the improved ballistics of modern times permit quite accurate firing within reasonable ranges, so that it will be a most difficult task to destroy or to subdue the fire of modern fortifications by purely fleet operations. The ship can still run past the forts, and it must be arrested under the fire of the forts by submarine mines or other obstructions, or barrier forts will prove unsuccessful.

The accuracy of fire with the new B. L. mortars has been carefully studied and their probable rectangles calculated from actual practice. It is apparent that within ordinary range a battery of mortars would prove most destructive to ships at anchor, but with ships underway and with sufficient room to manœuvre, their fire would not prove very dangerous provided the ships changed their speed and course from time to time.

Lieut. Hawthorne, First Artillery, in a paper in a late number of the Journal of the U. S. Artillery, raises the question of vessels anchoring when attacking forts. He says: "The attack on the forts at Hatteras Inlet gives a strong contrast between the values of a fire from ships moving and that from ships at anchor within fair range. The accuracy with which a moving object can be found by modern range-finders on shore makes the method of anchoring all the more necessary, as the range-finding thus becomes nearly facile for both sides." Now, apart from the great danger of anchoring within mortar range, there are other things to be considered that make anchoring before fortifications inadvisable. If with these fortifications there are no mobile defenses, neither battle-ships, rams nor torpedo boats, if there are no well placed mortar batteries, and if there is no danger of an enemy's fleet appearing upon the scene, an admiral might consider the advisability of anchoring his fleet so as to give his vessels a steadier gun platform. Even then he would hesitate, for he would be sacrificing one great advantage of the mobile force. Both ships and forts will be supplied with range-finders, the latter somewhat more accurate, but both sufficiently accurate to be within the errors of the gun. Both must predict the range when the ships are moving, because it takes some little time to read off the range, transmit it to the gun, set the sights, lay and fire the gun. The movement of the ship must be allowed for or the sights will be wrong when the gun is fired. Both must predict the distance between the ship and the fort at the time the gun is to be fired, and the one controlling the motions of the ships can do this with far greater accuracy than he who, if he depend upon the ships moving with regularity in speed and direction, may be easily deceived. On board ship the gun's elevation will be fixed so as to be correct at the time of firing, and the train will be altered by keeping the sights on. The usual way on shore will be to lay the gun both for train and elevation for some point

where by means of range-finders and tables the battery commander predicts that the ship will be at a certain future time. The gun is fired at this time. Now with the ships anchored the prediction will be accurate and the ship will probably be struck if within reasonable range, but if the ship is moving, a change of direction or speed or both will throw the prediction out, whereas the necessary change can be predicted for the moving gun by the officer controlling her movements.

Lieut. Hawthorne also draws certain conclusions from the British attack on Alexandria, but the conditions of the defense of this port were such as to make it very dangerous to infer that it would be safe to moor when bombarding modern fortifications, even when high angle fire was not used against the ships. And the damage inflicted by the bombardment was not such as to encourage ships to attack forts. At the expiration of the bombardment the ships had exhausted their supply of ammunition, and the injuries inflicted on the forts and on those who manned them were comparatively trifling; and if the Egyptians had been a well trained and well disciplined force, the bombardment would have been ineffectual and some of the ships might have been seriously injured.

The French have made some recent experiments of the effect of gun fire upon shore defenses, and while the accounts are not very definite as to the conclusions reached, the introduction of howitzers for high angle fire on some vessels shows that they found that the gun with a low trajectory was not very efficient when attacking land defenses. This does not affect us greatly, except it tends to show how much assistance can be given to the mobile defense by a few guns properly placed on shore.

The entire question of the manner of attacking fortifications with ships is too large a one to give it more than a passing consideration in this article. The difficulties of drawing accurate conclusions from history are very great, owing to the great changes in the weapons employed. Barbette and casemate batteries, as is shown by history, can be silenced for a time by a concentrated fire from ships; and if they were the principal reliance of the defense, ships would naturally come to close range and crush down the fire of the forts with their rapid-fire guns. This might permit them to remove the obstructions, pass the batteries, work the slow heavy guns with effect, or land troops for the occupation of

the forts, all without undue exposure to danger. The case is certainly different when mortar batteries and disappearing guns are used; their history has yet to be written, but knowing how little permanent injury has been inflicted on the fortifications by ships, the hope of silencing their fire, even temporarily, except by long bombardments, would seem very slight, and the rapid-fire guns would be of little value against guns so emplaced.

The Assistant Secretary, Mr. McAdoo, in his address delivered at the opening of the War College in 1896, clearly pointed out the necessity of a closer connection between the army and navy, particularly upon the subject of coast defense. Unless the navy is consulted in a matter so purely naval, the importance of shore defenses will be exaggerated to the detriment of our sea power, and the shore defenses will not be well suited to the purpose for which they are constructed. The nation may be lulled into a feeling of security by a large system of coast and harbor fortifications, while the great arteries of commerce may be exposed to the grasp of the enemy.

Lines suitable for the concentration of the battle fleet, such as the Penobscot-Portland line, the Gardner's Bay-Fisher's Island line, and the Key West-Tortugas line, are more important to the people of the United States than the fortification of any number of harbors. Until the mobile defenses on these lines are reduced no great operations can be undertaken by the enemy, and large portions of the sea-coast communications will be protected. It is the duty of the naval officer to select and point out these lines, to point out what class of attack is likely to be made upon any port or base, and to prevent extensive fortifications being erected where only light draught unarmored cruisers may be expected to conduct the attack.

The naval force should not be localized, but should be concentrated and placed between the enemy and our communications along carefully selected lines. The fortifications can only protect their immediate locality and cannot prevent the enemy from interrupting the communications. Each has its advantages while utilizing its peculiar functions, and each becomes extravagant when usurping the functions of the other. It would be far better to have some of our largest ports laid under contribution, their shipping destroyed and their docks laid waste, than to have our water communications blocked for an extended period. And far

better that the country should have no navy than that its vessels should be scattered and locked up in various ports for harbor defense.

THE FLEET IN BEING.

When defending our coast by occupying the lines with fortified bases our fleet must be handled as an active "fleet in being," and the doctrine of the "fleet in being" becomes of great importance to us.

The value of technical phrases is readily appreciated by all of us. Such phrases as "Sea Power," "Command of the Sea," "Fleet in Being," etc., are of great use as serving to crystallize a set of ideas into a few words. But the use of these phrases is not without danger. To the non-technical mind an argument bristling with technical terms is apt to be convincing even if the foundation is weak; but this is the lesser danger. The real danger is that students of the subject are inclined sometimes to enlarge the idea until the facts upon which it rests are lost sight of. The term "Fleet in Being" has at times been so badly misused as to cause much controversy. Some have so lost the substance while retaining the form as to endow the weak fleet with powers far beyond those it could hope to exercise.

The difficulties encountered when studying naval history are very great, especially so before the advent of the luminous writings of Mahan, Colomb and Laughton; and the ruling laws of strategy and tactics are so clouded by collateral events and conflicting narratives that in ascertaining these laws the deductive method is apt to be preferred to the inductive, and the theory is first formed and afterwards the facts are hunted up from many examples. This sometimes leads to a distortion of the facts to fit the theory, and may serve to weaken a good theory or to bolster up a bad one.

The term "fleet in being" was first used, I believe, by Admiral Herbert, Lord Torrington, in his defense made by him during his trial after the battle at Beachy Head. Torrington was tried and was acquitted in spite of the efforts of the ministry. Admiral Colomb seized upon the term and has used it in illustrating one of the laws of strategy in his most valuable book, "Naval Warfare." The conduct of Torrington on that occasion has been the source of much dispute, and writers have put many interpreta-

tions upon the doctrine of the "fleet in being," varying as their opinions of Torrington vary. The great value to the policy of Great Britain of the correct interpretation of this term is due to the fact that many of the arguments for and against large land forces and numerous fortifications center around the phrase. Admiral Colomb has shown clearly, as have some others, the importance to Great Britain of a powerful navy and the uselessness, even harmfulness, of extensive immobile defenses when the naval force is adequate. His opponents, who play upon the fears of the credulous, endeavor to upset his reasoning by asserting that he relies too much upon the "fleet in being," then giving their definition of a "fleet in being," and showing the absurdity of placing any reliance in an idea.

A correct interpretation of the term is important to this country, as for many years to come we cannot hope to have a fleet of equal force to such a one as might be brought against us by some of our possible enemies, and therefore we must know how far the doctrine holds good. We must avoid both extremes, one of exaggerating its importance and inducing us to be satisfied with an inadequate fleet, and the other of belittling its importance, inducing us to place our trust in fortifications. There is no doubt that some civilian, and I am afraid some military, minds have been so pleased with the term "fleet in being" as to consider the theory to apply to a small fleet lying passively behind fortifications without information or too far from the theatre of operations to act upon information, and to hold such a fleet so situated as sufficient to paralyze the actions of a strong active fleet.

Admiral Colomb, in his account of Torrington's movements before and after the battle off Beachy Head, plainly sets forth the doctrine of the "fleet in being." Torrington's idea was that it was his duty to closely follow the movements of the French fleet, and that his so doing would prevent that fleet from attempting to land troops, detach a portion of the fleet for other operations, or attack either Killegrew's or Sir Cloudesley Shovel's fleets before crushing his fleet. That if he attacked the French fleet and was badly beaten it would enable the French to accomplish any or all of the objects mentioned. And that with the odds against him the possibilities of defeat were too great to justify him in running the risk of an action. He also knew that he was likely to grow stronger as time elapsed, and the French were likely to grow

weaker; besides, he might be joined by the two squadrons that were forming, and could then hope to defeat the French. He was ordered by the Queen Regent to attack, and did so off Beachy Head, but adopted such tactics as to avoid a decisive action. His tactics have been severely criticised, and they were certainly faulty had he intended to risk all in this battle, as he kept a large portion of his force from coming to close action; but they were well suited to his ideas, and while beaten he was able to withdraw his vessels still organized as a fleet. He was imbued with the idea that if his fleet was lost the kingdom would be open to invasion at a time when the king and the best part of the army were in Ireland, and therefore, while obeying the order, he avoided a decisive engagement. He says: "Had I fought otherwise our fleet had been totally lost and the kingdom had lain open to invasion. What then would have become of us in the absence of his Majesty and most of the land forces? As it was, most men were in fear that the French would invade, but I was always of another opinion, for I always said that whilst we had a fleet in being they would not dare to make an attempt."

Tourville failed to make the best of his partial victory; he chased, but without vigor, and the allied vessels remained an organized fleet. Admiral Colomb says: "So that, even though the beaten allied fleet had come to an anchor at the Nore in great confusion; and expecting that the French might attack them, all the buoys were taken up, and other necessary dispositions made as soon as they got there, yet the strategy of the conditions was such as to leave and keep the great French fleet powerless. If, indeed, the enemy had followed up and beaten the fleet at the Nore, absolutely all would have been at his mercy. But a 'fleet in being,' even though it was discredited, inferior, and shut up behind unbuoyed sand banks, was such a power in observation as to paralyze the action of an apparently victorious fleet either against sea or shore." Here the opponents of the "fleet in being" theory generally take issue. They deny that a discredited and inferior fleet, shut up behind unbuoyed sand banks, is such a power as could paralyze the action of a powerful victorious fleet if it were well commanded. Admiral Colomb is careful to use the term "power in observation," and his critics fail to appreciate the value and weight of the term. It means the power to come out and as an organized fleet observe the motions of the

enemy, and frustrate any hostile action he might attempt by attacking him at such times when he would be liable to defeat. Had Torrington's fleet been found by Tourville at anchor in the Nore and showing little disposition to come from behind the banks, Tourville might have left a few vessels in observation and proceeded against Killegrew's or Sir Cloudesley Shovel's fleet, and he might have succeeded in beating them in detail. But he found Torrington's fleet was keeping in touch with him and was attacked by him, so that he felt certain that Torrington would continue to be an active "fleet in being" and follow his actions closely.

Mr. David Hanway, in an article in the *New Review* for October, 1895, attacks the generally accepted idea of the "fleet in being." He says: "All through the arguments of the believers in this kind of fleet [the fleet in being] it is taken for granted that there are some trustworthy means of avoiding battle and yet paralyzing the enemy." "What the partisans of the 'fleet in being' have got to prove is that there are some means—not dependent on accident, or on the presence in the hostile ranks of cause of weakness, due to moral, material or intellectual conditions—which enable a force, so far weaker that it prefers to avoid battle, to escape being forced into action, and at the same time to 'paralyze' its opponent." Admiral Colomb answers him in four articles in the *Broad Arrow* for October and November, 1895. In these articles he plainly points out the limits of the "fleet in being," that is, that while this fleet is in active existence there is a limit to what the more powerful fleet may reasonably expect to accomplish and that there is no occult power invested in the mere name. He says, speaking of Torrington, "But he knows that when it [his fleet] was intact and in sight of the French fleet, and when it was at the Nore repairing damages after the battle, the question was for the French, not for the English. The French 'would not dare to make an attempt.' 'Had they dared,' he seems to say to us, 'I should have attacked them at all hazards, and the knowledge that I would attack them at all hazards is that which would prevent them from daring.'" That is, that it was too hazardous for a wise admiral to attempt to land troops in the face of an active fleet. He also quotes De Tourville: "If they had thirty ships of war more than the fleet of your Majesty they might make their disembarkation, while

leaving ten ships of war with their transports and coming with the rest of their fleet before that of your Majesty in order to offer it battle." Here the main fleet would paralyze the "fleet in being," while there would be sufficient force left to guard the disembarkation against a few escaping vessels or scattered effort. Again Colomb says: "When we prepared for the capture of Belleisle in 1761, Keppel took seventeen sail of the line to cover the landing of 10,000 men, and he dispatched twelve sail of the line and three frigates to Brest to mask the force there. It is safe to say that Belleisle would not have been attacked if there had not been there twelve sail of the line over and above the force necessary to cover and support the landing." Had such been the case the inferior "fleet in being" in Brest, by its effect on the mind of Keppel, would thus have kept the island in the hands of the French.

Again Colomb says: "There is positively nothing in the phrase 'fleet in being' and in the doctrine behind it than the question of the amount of naval force any power must provide which thinks of undertaking serious invasion. Torrington could not possibly have meant more than what De Tourville said in his memorial to the King of France. Any power undertaking to invade a country over the sea must provide two fleets, one to cover the landing, and the other to mask, overawe and 'paralyze' any naval force that the enemy may possess, and which, but for this 'paralyzing,' might be expected to interfere with and perhaps stop the landing, as Tegethoff did at Lissa."

A discussion on this subject was raised in the Army and Navy Gazette, August and September, 1895, by an editorial on an article that appeared in Macmillan. This discussion is particularly valuable, as during it Professor Laughton gave a definition of the phrase "fleet in being." He says: "A 'fleet in being' is a fleet which is neither cowed, crushed nor effectually masked, and is still able to threaten interference with an enemy's plans of territorial attack." This is clear and to the point; but I think for the sake of accuracy it should be limited slightly in one direction and extended in another. The following definition, which is Professor Laughton's slightly amended, more accurately represents, I think, the present doctrine: A "fleet in being" is a fleet, *relatively inferior to the enemy*, which is neither cowed, crushed nor effectually masked, and is still able to observe

and to threaten interference with an enemy's plans of territorial attack, *coast blockade or other extended operations*. It is necessary to limit the "fleet in being" to a fleet inferior in force to the enemy, otherwise the phrase would lose some of its value as being too indefinite; and it is necessary to extend the possible operations of the enemy that he is also prevented from undertaking by the danger of interference while the fleet is in "being," and the fleet must be able to observe or it would be unable to threaten interference.

The writer of the article in Macmillan says: "But that is not what the 'fleet in being' was when I saw it. Then it was a weaker fleet, which had some power of at once paralyzing the enemy, and escaping being forced either to fight or show itself useless. I neither did, do, nor can believe in any such fleet." Here the writer shows plainly his difficulty in understanding the limitations of the phrase. It is true the "fleet in being" is a weaker fleet, but it does not paralyze the enemy, it only forces him to devote his attention to the weaker fleet before undertaking other operations. He must force the weaker fleet to fight or he must mask it. The "fleet in being" will attempt to avoid being forced to fight a decisive battle until it can do so with chances of success; but to remain a "fleet in being" it must actively threaten the enemy and show itself ready to attack upon favorable opportunity arising. The strongest defense is made by attacking the coast of the enemy; but with a weaker fleet this is impracticable, and then it becomes necessary to take advantage of the strength gained by short lines of communications and by coast fortifications. It is not by refusing to fight that the "fleet in being" defends its coasts, but by forcing the fight at the proper moment. It must be remembered that the attacking fleet labors under many disadvantages as compared with the defending fleet. Its lines of communication are longer. While for a short time a fleet may exist without supplies, a modern fleet soon requires coal and ammunition, and even with supply ships, must find anchorages where a portion of the fleet can coal and take supplies. Having steamed from its base to the enemy's coast, the vessels of the attacking fleet will need coal before those of the "fleet in being," and here is the latter's opportunity to force a fight with the fleet nearer equality. Again, the defending fleet will have torpedo-boats and a mosquito fleet

to aid in constantly harassing the enemy that may again aid in reducing the odds and enabling the "fleet in being" to force the fight to advantage. Where not running serious risk of being masked, advantage may be gained by leading the attacking fleet into narrow waters, by utilizing the facility for repairs, and above all, advantage can be gained by placing the fleet along a line of defense, with fortified advance bases, so that the larger fleet will be forced to attack while the "fleet in being" will be assisted by the land defenses and the position of the channels. It is by taking full advantage of all these favorable conditions that the "fleet in being" gains its power, by choosing the time and place to fight, and not by avoiding fighting, that it is enabled to "paralyze" the larger fleet, that is, to prevent the larger fleet from attempting to attain any of its objects before fighting the smaller.

The "fleet in being" must be an active, not a passive fleet; it must be kept in touch with the enemy, or be held in positions that will obstruct the advance of the enemy. It must be held on lines of defense where it is free to move with its force fully developed; not shut up in fortresses or behind shoals where it may be blockaded or masked and from whence it can expect to make its escape only by vessels and not as a fleet.

The true objective of the fleet is the fleet of the enemy, and success either in attack or defense can only be gained by fighting.

THE STRATEGIC POSITION OF HAWAII.

Honolulu, the capital of Hawaii, is on the island of Oahu and centrally located in the Pacific Ocean. It is 2016 miles from Unalaska, 2395 from Sitka, about 2300 from the British naval station at Esquimalt, 2305 from Port Townsend, 2089 from San Francisco, 3310 from Acapulco, 4665 from Panama, 3399 from Yokohama, 4961 from Hong Kong, 4614 from Sydney via Apia. It is the natural stopping point on all routes from America to China and Japan, and lies between the ports of British Columbia and Australia. It is about 2000 miles from all the Pacific ports of the United States, from San Diego in the south to Unalaska in the northwest. The importance of its position, both commercially and strategically, would be greatly increased by the opening of the Nicaragua canal.

It is not within the province of this paper to attempt to discuss the commercial value of the Hawaiian islands to the United

States in time of peace, but to endeavor to show how important they must be to the United States in time of war, from their strategic position. Any one considering the defense of our eastern coast must see at once the difficulties that would be removed with Bermuda out of our way, and the advantages they offer to Great Britain should she be the attacking party. The Hawaiian islands would not be as valuable as Bermuda to an attacking enemy, because of their greater distance from our coast, but they would be more valuable to us as a point from which to defend our transoceanic routes. It would not be difficult for us to hold the same position in the northeastern Pacific towards other naval powers that Great Britain holds in the remaining waters of the world; and if we really develop our foreign commerce and take advantage of the new and most valuable openings for trade in China, the only rival who should closely approach us in sea power would be Japan.

The advantage of outlying ports and coaling stations, in times of peace, is freely admitted on all sides. The controversy arises when the possibility of war is considered. The wisdom of Great Britain in seizing and holding her imperial fortresses, Halifax, Bermuda, Gibraltar and Malta; her imperial coaling stations, fifteen in number; and her other defended outlying ports, twenty-one in number, can hardly be denied; but then, say some strategists who carry the theory of "command of the sea" to extremes, Great Britain can hold these ports with honor and safety, as she holds command of the sea; but for other countries to do so would serve to weaken their power by attempts to defend them, and in the end would be furnishing an easy prey for the forces of Great Britain. And right here is a comparison used by nearly all strategists, a natural one, but one which if carried too far leads to error. It is natural to compare all sea force with that of the country pre-eminent in such force; but it would be foolish for a country to relinquish advantages or safeguards because, as against Great Britain, they might prove disadvantages or dangers, for there are other countries besides Great Britain who are struggling for the commerce of the world. This misconception of the theory of the command of the sea leads some to object to our attempting to hold Tortugas, and leads some of the French into the idiocy of commerce-destroying and torpedo-boat defense.

There are to be found men even in Great Britain, generally termed "Little Englanders," who would relinquish Malta and Gibraltar and would withdraw from the Mediterranean, because Great Britain would find it difficult, under some circumstances, to hold command of that sea, and because by relinquishing all effort there she would be stronger at other and more vital points. Relinquishing Malta and Gibraltar would be the first step on the road that leads to the disintegration of the British Empire and to the re-establishment of "Little England."

Let us see how far such an argument, if logically carried out, would take the "Little Englanders." Great Britain has long reigned paramount in the China seas. With her chain of ports and colonies between China and the mother country she has found it easy to maintain the strongest naval force in those waters, resting on Hong Kong as a base. But the condition of affairs in those seas is changing rapidly, and it is not hard to foresee the time when she will find it difficult and extremely expensive to maintain a fleet equal to that of at least two of the nations interested in those waters. Germany has made great advances in her trade with China, and Germany has a growing desire for colonies and a determination to create a large navy, but she has no chain of ports and no base at present in the China seas. France has been extending her territory at the expense of China. Her navy is second only to that of Great Britain. She has a broken chain of defended ports in Dakar, Reunion, Diego Suarez and New Caledonia, and a base at Saigon. Russia's territory borders China, her navy is large and increasing, she has the home base of Vladivostock, and this fortress will soon be connected by rail with the seat of her resources and her power. Russia, France and Germany dictated the terms of the China-Japan treaty, while England held aloof. But most important of all, a new sea power has arisen in the East, and Japan is now creating a navy that she can maintain easily at a strength greater than the forces that any other power can maintain in the China sea without great exertion and enormous expense. The manifest destiny of Japan, unless her new civilization be checked, is to be the great maritime power of the East. Would the "Little Englanders" withdraw from Hong Kong, relinquish their influence in China, and retire to India, because she cannot command all the China seas? What

would the great body of merchants, centered at Calcutta, say to such a policy? It is well known that their counsels are almost supreme at London when Eastern affairs are considered. Is it not plain that such a policy of retreat would lead to the disintegration of the British Empire? It is this mistaken view of naval strategy that would lead us to reject the Hawaiian islands, for although we are not dependent upon colonies, we have a coast to protect with some commerce that is destined to be a great source of wealth.

Is Great Britain the only country that can afford to hold coaling stations? The military doctrine that applies to islands, coaling stations and outlying ports separated from the military strength of the country by water is intimately connected with the doctrine of the "command of the sea." The primary object of each maritime power in time of war is to obtain "command of the sea," and until this is obtained it is hazardous to attempt other operations, such as invasions, territorial attacks, blockades or commerce-destroying on a large scale. A country may have "command of the sea" in a general sense and yet its enemy may hold command in certain localities. Again the time limit becomes important. Some operations, such as serious invasions, might require that the "command of the sea" be held for a practically unlimited time, whereas an important raid might be made with the command lasting for a short time only. Fortresses, coaling stations and defended ports all would have a limit to their endurance. For each one the force necessary for its capture and the time it could hold out against such a force could be calculated. That is, against each one might be placed a figure representing the force and time necessary for its subjugation. Let us say that Great Britain had lost command of the Mediterranean and that it was held by France, or France and Russia. Malta must fall eventually to the allies, but the allies must pay for it by the expenditure of a certain amount of material—men killed and wounded, ships sunk and injured, ammunition and supplies expended—and the force must be occupied a certain length of time and thus prevented from undertaking other operations possibly more important, while the time thus occupied might enable Great Britain to assemble a force sufficient to regain the command of the Mediterranean and with it Malta. Again, suppose we were at war with Great Britain and her fleet

occupied the Gulf of Maine and were off Boston. We might start out from the Chesapeake with our vessels and transports and seize Bermuda while we had temporary command in that locality. We could not hold it, for the superior fleet would drive us away and the troops would soon be made prisoners, unless they were transported back to our coast in time. The fact is that the entire expedition would be in great danger from the time of leaving until its return to our own ports, but we might have inflicted serious damage to the enemy. The danger of such eccentric operations is that it leaves the enemy free to inflict great damages without his running serious risks, and our vessels and troops might have been employed in the defense in a manner calculated to have a more lasting effect on the war as a whole. As it is, Bermuda adds strength to Great Britain's sea power.

In time of war a coaling station or defended port has great value as a point of refuge for merchant vessels, and as a point where your own vessels may reasonably expect to find coal and be able to take it on board with comparative safety. It would be valuable without a coal pile, for coal could be sent there in colliers. If undefended, the coal pile might be seized by the enemy and the colliers seized or driven away. Again, it is valuable as a point where your enemy's vessels cannot take refuge and where he cannot coal until he has reduced the fortifications. If this station was owned by you and undefended, or belonged to a weak neutral, your enemy might use it freely as a coaling station, and it would be next in value to him to one of his defended ports.

While Great Britain would be likely to have "command of the sea" if at war with any one or even any two naval powers, she would be without the local command at many points, and it is therefore necessary for her to fortify her coaling stations. She has four points where her fleet might be gathered for attack or defense, for repairs, coal, ammunition or other supplies, that she has deemed to be of sufficient importance to turn them into fortresses. These places are strong enough to resist a powerful attack for quite a period of time. Two of them are close to the coast of the United States. The coaling stations are only sufficiently strong to drive off raiders or unorganized attacks.

For the purposes of this discussion the defended places may

be divided into three classes. First, the class of small isolated islands where landing beyond the range of the fortifications would be practically impossible until the fortifications were reduced, but where those who man the forts were mainly or entirely dependent upon the supplies stored up before attack. Second, the class where only the entrance to a port is defended, where troops could be landed beyond range of the fortifications, and where ample supplies could be drawn from the immediate locality. Third, the class where a site is selected and fortifications erected so as to protect both sea and land sides, where ample supplies can be obtained unless the fortress is invested both by land and by sea.

The places of the first class must be reduced by ships either by direct bombardment, by starvation or by both. In this connection the following quotation from "Naval Warfare," by Admiral Colomb, is worthy of notice: "'Vessels are not yet, and never will be, able to fight on even terms with forts.' This broad issue, so put, is equivalent to saying that all the modern improvements in ships have been met by equivalent improvements in forts, and unless the capacity for engaging at longer range is a change, there is none. Other broad issues arising out of the bombardment of the forts at Alexandria are, that the surrender of a place cannot be achieved without troops to occupy any more now than formerly, and that the command of the sea remains a necessity." Places of the second class may be captured by landing troops at a distance from the guns of the fortifications and by bombardment. Places of the third class, if strong enough to resist bombardment, can be starved out only if invested on shore as well as at sea. Pearl Harbor, ten miles from Honolulu, can easily be turned into a port of this class.

There are some strategists who would leave all coaling stations to Great Britain because of her great "sea power"; they compare the coaling ports to outposts on shore that are required to withdraw to the main lines when likely to be cut off by a superior force. Still there are many cases where outposts are called upon to hold out to their uttermost, thus delaying the enemy, possibly frustrating some of his designs and admitting the possibility of a rescue. These arguments if carried to a logical conclusion would prevent all countries, other than Great Britain, from building up a navy, or would drive them to iso-

lated commerce-destroying as a means of waging a serious war. It is well to remember that time and material are valuable, and that even when no valuable time is lost, that for every dollar spent in defending the port the enemy must spend ten to capture it, and while capturing the port more important work may be neglected.

Should Hawaii be a part of the United States, at least we should secure it from having a fortified port in adverse hands at the beginning of the war. Of course we would be under obligations to protect it, but we do not hesitate to risk our wealth in San Francisco until it is so fortified as to be safe against an enemy. We will be obliged to protect Hawaii, but its possession will bring greater security than obligations to protect. Pearl Harbor can be securely protected from land and sea, and can be supplied easily unless closely invested. It would not be an expensive operation to render Oahu secure against anything but a strongly organized expedition, a strong military force of all arms and a strong naval force. Such an expedition would be impossible for any probable enemy until they had obtained "command of the sea" by crushing our naval force.

Hawaii, from its strategical position, belongs to the United States. It will be a source of strength and not of weakness. It will be a refuge for our marine and a danger to our enemy's marine. It can be readily protected, as well as fitted to assist in protecting our Pacific coast. And at the very worst, should we fail to afford it land protection and neglect our naval forces in the Pacific, it will not form an immediate refuge and base for our enemy. Every dollar spent in protecting Hawaii will require at least ten dollars from an enemy who attempts its capture, and the security gained, by holding our possible enemies at bay 2000 miles from our coast, cannot be estimated in dollars and cents.

Fortified bases, whether for coaling, for repairs, for supplies or for refuge, become sources of strength to a maritime power when they are well selected, and are only sources of weakness when selected without a definite place in a naval program, or when so situated that to protect them would require an excessive naval force, or the use of the naval force in an improper direction, that is, divert it from more useful aims. To attempt to hold a fortified port off the English coast would be to throw away a portion of our resources, for we could not hope to have local

command of the sea at such a point for any useful period of time, and at any time after the outbreak of war she could reduce it without fear of definite resistance from our sea forces. Whereas for us to hold the Tortugas or Bermudas would be to multiply our resources, as we could hold local command of the sea at such points, and such places could not be reduced until after our fleet had been crushed, and the possession of fortifications at these points would so strengthen our fleet as to require a much superior force to crush it. It must be remembered that cross raiding has little effect on the final results of a war. All the valuable possessions of the defense may become the property of the attack when it is successful, and improperly selected bases of the defense may fall to the attack without diverting it from the main issue, but well selected bases become an integral part of the defense and enable it to resist the attack, and should only fall after a complete failure of the defense, or after costing the attack such an expenditure of time and material as to proportionally weaken it. Not to create a naval force of sufficient power to make well selected bases valuable is to relinquish the attempt to conduct a successful defense against a maritime power, and to relegate all the vessels of war and all the fortifications near the sea front to attempting to defend isolated localities against strong attacks, so that a well equipped enemy could seize our fortified points one by one and even dominate our coasts without giving us the opportunity of making more than a feeble resistance. Would it not be better to trust to peaceful arguments to avert war, and when these fail to pay an indemnity to the aggressor, than to aggravate the enemy into increasing our penalty by making a feeble resistance? There can be no question but that in the present state of the morals of the inhabitants of this globe force must be met by force, and putting aside questions such as avenging insults, vindicating principles or righting wrongs, there still remains the necessity for a strong naval force with well fortified bases for the sole purpose of protecting our coasts and safeguarding our wealth, if not our lives and our liberties.

THE NICARAGUA CANAL.

An interoceanic canal connecting the Atlantic and Pacific oceans has long been desired by the merchants of all nations, and one under the protection of this country has for some years

been advocated by our statesmen and has strong support among our thinking people.

Among the many routes proposed, two have been accepted generally as the best, that is, Nicaragua and Panama. Any one examining the surveys and reports and weighing all reasonably accurate data would be at a loss to explain the selection of the Panama route, if unacquainted with the reasons other than economic that determined its choice. The history of the Panama canal is fairly well known at the present day. How, after the expenditure of millions, but little valuable work was left to show for the money that had taken wings, and how at the present time, after a slight resurvey, a pretense of work is again being made without any real attempt to overcome the serious natural difficulties.

It is difficult to believe that the Tehuantepec ship-railway was seriously considered by any number of men of importance, but it has been used to retard the important undertaking in Nicaragua.

Few can doubt the great commercial advantages to this country of an interoceanic canal; even the transcontinental railroads must see that although they may lose some heavy freight, that they must be the gainers by the establishment of a canal that will serve to increase the prosperity of both coasts and therefore increase the freight and passengers moving over their lines. Competition between rail and water routes is never real and never lasting; each route soon carries the class of freight for which it is peculiarly adapted, and the prosperity of one is increased by the establishment of the other.

Only those who believe in the certainty of universal peace in modern times can look without alarm upon the building of a canal between the Atlantic and the Pacific by a company virtually if not nominally under the protection of a European power. A new state on the American continent under the protection of a European power would be less menacing to the vital interests of the United States.

The commercial advantages of such a canal being admitted, so far as the interests of the United States are concerned, the next question is one of military policy. It does not require an expert to see the enormous advantages and great gain to the military strength of the country that have resulted from the close commu-

nication established by means of railroads between the Atlantic and Pacific States. When the mind is not clouded by the idea that forts form a satisfactory coast defense, and the value of ships is clearly understood, the advantage to us of a means by which our naval force can be concentrated on either coast becomes apparent. For then we would have no rival in the race for the command of the sea in the eastern Pacific, and our position in the Atlantic would be greatly strengthened. The radical difference between the railroads and a canal is that the former lie within our own territory while the latter must be located at some distance beyond. The one requires military and the other naval protection. The one is already secure; the other must be made secure by holding the command of the connected seas if we are to fulfill our manifest destiny and become a great manufacturing country.

Does such protection require a more powerful naval force than would be otherwise necessary to safeguard the interests of our country? It does not do to consider any of the great interests of a country as if they were so many isolated quantities, as in so doing grave errors must be committed. Doing so might lead to the following reasoning: That there was no utility in constructing a canal because of lack of commerce; no use to increase our commerce because of lack of naval force for its protection; and no use to build up the Navy because there was no canal and no commerce to defend. We cannot become a great manufacturing state or dispose of our surplus farming produce to advantage unless we increase our commerce. We cannot greatly increase our commerce unless we increase our merchant marine. We cannot increase our commerce and our merchant marine without increasing our responsibilities and therefore increasing the need for a naval force. With a naval force commensurate with our necessities we must become the dominant naval power in American waters, and the safety of all routes between the Atlantic and the Pacific be secured.

The consideration of the protection of the Nicaraguan canal draws out similar lines of argument to that of the protection of fortified bases. The distance of the canal from home bases becomes of vital importance. Any one of the great naval powers of Europe might maintain in its own waters an overwhelming force as compared to ours, and yet be unable to hold command of the

Caribbean sea or to attack Greytown with reasonable chances of success. Some of these powers have bases in these waters, while up to the present time we have neglected all our opportunities; but while these advance bases would enable them to maintain a limited force for a limited time in the waters in question, the distance between the advance and home bases would prevent them from maintaining a powerful force there, and would make it doubtful for a limited force for an extended period during war. Without advance bases, except such as would be seized at the time, a powerful force operating in these waters would be possible for us when impossible for a European power, and with proper advance bases we could maintain command of the Caribbean sea without straining our resources. The problem on the Pacific coast is less complicated. There the ease with which we can command the sea is apparent, and it only requires a little thought and use of opportunities to prevent unnecessary expense.

DEPTH AND DRAFT.

The depth of water in the channel leading into any harbor should be the ruling element in the design of its defenses. For the draft of the attacking ships is limited by the depth of the channel, and the armored protection of the ship is somewhat proportional to its draft. Ships may be heavily armored and yet be of light draft, as are our monitors; but in securing light draft and maintaining heavy armor and armament, coaling radius and sea-going qualities have been sacrificed. It is not likely that any such vessel would cross the ocean to attack our coasts. Again it is the general rule, although there are notable exceptions, that the calibre of guns corresponds in some degree with the amount of armor carried. Small calibre guns do not require very heavy fortifications, and it would seem reasonable that the class of guns to be carried in the forts should be determined by the class of ships that is likely to attack them. A well located shell from a large calibre gun, 10-in. and upwards, would be sufficient to seriously damage or destroy an unarmored cruiser. But large calibre guns are loaded, aimed and fired slowly, and the percentage of hits in actual combat is not likely to be large, even if the vessel is not moving rapidly, and of course the percentage of well located hits must be much smaller. A fair sized battery of rapid-fire guns would be almost certain to stop a cruiser that

might pass a few 10-in. guns without serious damage; and the cost of such a battery would be much less than that of the emplacements, carriages and guns of the heavier calibre. When unarmored vessels only can be expected to make the attack, the defense made by a rapid-fire battery would have the advantage over guns of larger calibre in the points of efficiency and expense as well as of choice of location, etc. That the greater range of the larger calibre can be neglected fairly must be admitted by all who have given the subject full consideration. At great ranges the slightest change in the weight or conformation of the projectile, in the quantity or quality of the powder, in the temperature of the gun, in the condition of the atmosphere and in the direction of the wind, the slightest difference in any one of these uncertain quantities is sufficient to cause a clean miss.

Let us consult one of the late lists of the war vessels of Great Britain and pick out all the armored vessels drawing less than 20 feet. We find the *Penelope*, 4470 tons, drawing 17 ft. 6 in., capable of steaming 1360 miles at 10 knots speed, carrying eight 8-in. muzzle-loading rifles and protected by 6-in. armor. The *Glatton*, 4910 tons, draft 19 ft. 6 in., steaming radius 2000 miles at 10 knots, guns two 12-in. muzzle-loading rifles, armor 7 to 14 in. The *Cyclops*, *Gorgon*, *Hecate*, and *Hydra*, 3560 tons, draft 16 ft. 4 in., steaming radius 1250 miles, guns four 10-in. M. L. R., armor 5 to 10 in. The *Magdala*, 3340 tons, draft 15 ft. 3 in., steaming radius 800 miles, guns four 8-in. B. L. R., armor 7 to 10 in. The *Abyssinia*, 2900 tons, draft 15 ft., steaming radius 1000 miles, guns four 8-in. B. L. R., armor 6 to 10 in. The *Scorpion* and *Wivern*, 2750 tons, draft 17 ft., steaming radius 1150 miles, guns four 9-in. M. L. R., armor 4.5 to 5 in.

All of these vessels are armored with iron plates, and their water line belt can be pierced by 6-in. guns. All are slow, and only one carries sufficient coal to steam 2000 miles. All but two are armed with muzzle-loading guns. The two armed with breech-loading guns were built for the coast defense of India and have a very limited coal endurance. In fact we may conclude that all of our ports whose channels have only 20 feet of water are secure from attack by armored vessels except where sufficiently near the sea to permit of distant bombardment.

Again consulting the list for vessels drawing under 25 ft. we find the following in addition to those already mentioned. The

Conqueror and Hero, 6200 tons, draft 24 ft., steaming radius 5200 miles, guns two 12-in. B. L. R., armor 8-in. to 10-in. compound. The Audacious, Invincible, and Iron Duke, 6010 tons, draft 23 ft. 8 in., steaming radius 3900 miles, guns ten 9-in. M. L. R., armor 4-in. to 8-in. iron. The Belleisle and Orion, 4870 tons, draft 21 ft., steaming radius 1850 miles, guns four 12-in. M. L. R., armor 6-in. to 12-in. iron. The Rupert, 5440 tons, draft 23 ft. 7 in., steaming radius 1350 miles, guns two 9.2-in. B. L. R., armor 7-in. to 12-in. The Hotspur, 4010 tons, draft 21 ft. 10 in., steaming radius 950 miles, guns two 12-in. M. L. R., armor 7-in. to 11-in. iron. The Prince Albert, 3880 tons, draft 20 ft. 4 in., steaming radius 950 miles, guns four 9-in. M. L. R., armor 4.5-in. to 5.5-in. iron. And the Aurora, 5600 tons, draft 22 ft. 6 in., steaming radius 8000 miles, guns two 9.2-in. B. L. R., armor 10-in. to 16-in.

Of these the first five are the only ones that could be brought against our fortifications. The first two are fairly formidable vessels, but their armor can be pierced by 8-in. guns. The Audacious, Invincible, and Iron Duke could not work their muzzle-loading guns against a battery of rapid-fire guns, and a large proportion of their armor can be penetrated by 6-in. guns. England has many formidable battle-ships, but they all draw over 25 feet and many closely approach 30 feet. So that for harbors whose channels have only 25 feet of water, except when it can be bombarded from the sea, the defense will be stronger if rapid-fire guns are used than if larger calibre were preferred. Even where the exception rules, guns of heavy calibre may make bombardment slightly dangerous, but it can only be prevented by the use of battle-ships and torpedo boats.

Now if we examine the charts we will see how very few harbors of importance will admit vessels drawing over 25 feet. Portsmouth, Newport, New London, New York, Baltimore (by a dredged channel), Key West (by the S. W. channel which is not safe), and New Orleans (kept open by jetties), are the principal deep water ports on the Atlantic Coast. It is expected that Boston and Norfolk will have 30 feet dredged channels at an early date. These harbors would require shore defenses against battle-ships, remembering that dredged and other narrow channels can be readily rendered impracticable with ground mines and other obstructions.

In reviewing the report of the Chief of Engineers, for the last year, one is struck at once with the large amount of work that has been completed on emplacements for heavy guns and mortars as compared with that for smaller guns. To be sure there are two good reasons for this, one that such important ports as New York require many heavy guns and mortars, and the other that as emplacements for the heavy guns take far longer than those for rapid-fire guns, it is well to undertake the installment of the heavy guns first. There are some points where even heavier guns could be used to advantage, and others where it is to be hoped heavy guns will be installed, but surely ten-inch guns are not required at Portland with 21 feet of water, or at Washington with 20 feet, or 12-in. guns at Charleston with only 15 feet of water. If these guns are intended to prevent distant bombardment they should be of heavier calibre, certainly not less than 13 inches, and if they are intended to drive off cruisers they are too large. The recommendations of the Endicott Board appear to be the guides that are being followed, but conditions have changed somewhat since they were made, displacements have increased and consequently draft, armor has been improved, the rapid-fire gun has been developed, and the plans should be altered to meet the new conditions.

TYPE OF WAR-SHIPS.

All naval powers appear to be agreed upon the necessity of three broad types, viz. battle-ships, cruisers and torpedo boats; but armored vessels are constructed upon largely varying designs, so that there are not only numerous other types besides battle-ships, but there are many vessels that are placed in one type by some authorities and in another type by others. The line between battle-ships and armored cruisers is far from distinct. Again, heavily armored vessels differ so in their steaming radii as to range from vessels fit for little besides harbor defense, through coast defense vessels, to sea-going battle-ships. Cruisers are so varied in design as to furnish examples to suit the most erratic fancy. Torpedo boats range from destroyers of about 350 tons to small launches. Besides these we have vessels designed for special purposes, such as rams, dynamite cruisers, etc., etc.

The question of the necessity of building battle-ships has been raised frequently. The strongest opposition to them is centered

in France, and Admiral Aube has a large following, but they have been unable to control the building policy of that country for any extended period of time, and France continues to build battle-ships, although the designs are somewhat controlled by similar ideas to those that would stop their building.

In analyzing the many arguments raised in France for and against the building of battle-ships, the ruling idea that appears to permeate those from the new school is that there is one type suitable for the strong naval power and another for the weak. That France cannot afford to build and support such great fleets of battle-ships as England has built and is building, and therefore should put her faith in fast cruisers and torpedo boats. That there is one set of rules of strategy for the strong and another for the weak. Similar ideas led to our policy of building gun-boats instead of ships of the line and frigates, and has led to the building of many harbor defense vessels. Such ideas can only prevail because of a thorough misconception of the uses of sea power and the history of sea fights, and restricts the area of the influence of sea forces so as to make them little more than adjuncts to land forces. They limit the final operations of battle-ships to attempting to knock down forts, and would make the destruction of a great coast fortress valuable, even though it belonged to a country without naval or merchant marine. In other words, they fail to see that the true value of a fortress is to protect the inlet and outlet for trade, the vessels carrying the trade, the vessels protecting the trade, and the supplies, munitions of war, repair shops, etc. Without the vessels the fortress loses most of its value, and with the vessels cooped up within its protection its value is measured by the force of the enemy required to close its mouth. If they build any battle-ships they would build them to protect their coast, and they build fortresses to protect their battle-ships. The problem of selecting sites for fortifications on and near the coast line does not differ greatly from that of selecting them in the interior. Few engineers of the present day would think of designing immense fortresses with the idea of safeguarding an army inside. The example of Metz would be sufficient alone to prevent like errors. Why then Bazaine our fleets? Fortifications are designed to strengthen portions of the line of defense of an army, and to protect its supplies, munitions of war, and lines of communication, but not to enclose it. The value of an army is

mainly dependent upon its mobility, and, although fortifications may be built around a city to strengthen its defense, the army that should seek refuge within would be partially defeated, its value for the time seriously diminished, and even the defense of the city weakened. So with coast and harbor fortifications; they should be designed to strengthen the lines of defense of the battle fleet and to protect its supplies, etc. They should also be designed to protect cities and harbors, and usually these would include points of supply. But the battle fleet, like the army, should have room to manœuvre even when fighting on the defensive.

Battle-ships are not designed to attack land defenses, but to meet other vessels on the sea; and, while they may at times successfully bombard fortifications, they will do so only under exceptional circumstances, and will need land forces to succeed in extensive operations.

The greatest blow to the adherents of battle-ships has been struck lately by Admiral Colomb. The blow is severe more because of the high reputation of its author than from the weight of the argument. Admiral Colomb is one of the most advanced thinkers on naval subjects, and, in my opinion, his deductions from history are better guides than those of any other modern writer. This makes his predictions as to battle-ships the more surprising. What might be brushed aside if uttered by other men requires careful consideration when it comes from the mouth or pen of Admiral Colomb. There is one saving feature in the case, and that is the well known tendency of the Admiral to make assertions when desiring to evolve an argument and to force consideration of a subject, that, while expressing his views, are easily twisted into other meanings. In fact, any one holding opposite opinions to the Admiral is apt to argue as if the Admiral held extreme views, and then he finds he has been fighting the air, as the Admiral comes back with a clearer statement of his ideas. In this case it seems as if there were no opportunity or excuse for misstating the views of Admiral Colomb, and that he has plainly placed himself on the side of the destroyer as opposed to the battle-ship, and that he believes it is time for Great Britain to cease building large battle-ships, that an entire change in type is necessary, and that something similar to the destroyer type should take the battle-ship's place. He assumes that the battle-ship has

reached its final stage of development, that the type has reached its highest point of efficiency, and that the logical deduction from this assumed fact is that a new type must be evolved to fight in the line of battle. This new type he seems to think will be of the nature of a modified destroyer. He seems to think that a number of destroyers, whose aggregate cost would be less than the cost of one battle-ship, would be more than a match for her.

If there is any one thing more than another for which Admiral Colomb is justly celebrated it is his power of predicting the future and guiding the present state of naval affairs by lessons drawn from the past. One can readily imagine how he would have scathed an advocate of a policy of building small vessels to take the place of the great vessels of the line, and what ponderous blows he would have aimed at his adversary had he not been imbued with ideas that have forced him to take the side of the small vessels. Under other circumstances what admirable examples he would have drawn from history to show the necessity of battle-ships, and how he would have shown that in each change of design the logic of events forced the building of greater vessels. Now he is limited to one lesson of the past, that is, when a type approaches the point of perfection a new type better adapted to the modified circumstances must be developed. One cannot cease to regret that a writer so powerful in argument should be found arrayed against the battle-ship.

One of the strongest examples of history that can be brought forward on the side of the small vessel is the defeat of the Spanish Armada. Here the small swift vessels of the English were more than a match for the large unwieldy vessels of the Spanish, yet England and the maritime world did not draw the false conclusion that smaller vessels were the best—they modified their vessels of the line so as to make them sufficiently powerful to overwhelm a large number of the smaller vessels.

Froude, in his lecture entitled "The Sea Cradle of the Revolution," speaking of the reign of Henry VIII, says: "Genius kindled into discovery at the call of the country. Mr. Fletcher of Rye (be his name remembered) invented a boat the like of which was never seen before, which would work to windward with sails trimmed fore and aft, the greatest revolution yet made in ship-building." This was about the year 1539. All through the set of lectures delivered by this author at Oxford, 1893-94, the advan-

tage of this invention can be traced, and the evidence that the Spanish were backward in adopting it. "Their safety depended upon speed of sailing, and specially on the power of working fast to windward, which the heavy square-rigged vessels could not do." "The Pelican sailed two feet to the Cacafuego's one." "However that be, the brigantines and sloops used by the Elizabethans on all adventurous expeditions were mere boats compared with what we should use now on such occasions. The reason was obvious. Success depended upon speed and sailing power. The art of building big square-rigged ships which would work to windward had not yet been discovered, even by Mr. Fletcher of Rye. The fore and aft rig alone would enable a vessel to tack, as it is called, and this could only be used with craft of moderate tonnage." (1562.) "With some surprise the Spanish officers saw Howard reach easily to windward out of range and join Drake." (Sailing of the Armada.) "New-modeled for superiority of sailing, the English ships had the same advantage over the galleons as the steam cruisers would have over the three-deckers. While the breeze held they went where they pleased." (Same.) "The English ships had the same superiority over the galleons which steamers have now over sailing vessels. They had twice the speed; they could lie two points nearer to the wind." (Defeat of the Armada.) There were other things that led to the defeat of the Spanish Armada, but the small swift schooners of the English were the most important factors. They could choose their position so as to inflict the greatest injury to the Spaniards while receiving the least harm. Their low sides made them difficult to hit, and their power of beating to windward enabled them to move around the unhandy galleons at will, when there was sufficient wind. Their armament was superior to that of the galleons, and with some little increase in calibre of their guns they would have occupied the same position towards the ships of the line that the destroyers do to the battle-ships at the present time. The galleon was improved. The sails and spars were so improved as to permit of the square-rigged vessel making very fair work to windward, and the armament was so improved as to insure sinking the schooners at a single broadside. Each great change in type has resulted in an increase in the size of vessels designed to fight in the line of battle, from the introduction of sails, through that of steam, up to the mastless ironclad.

It would seem as if the limit in size had been reached, at least for the present, but it is going very far to assume that the present type has neared its highest point of perfection.

The present position seems to be this—that the small size and great speed of the destroyer, together with the power of its weapon, make the destroyer a most formidable enemy to the battle-ship. Many consider that at night-time several destroyers would be almost certain to defeat a battle-ship, and possibly in the day-time. Admiral Colomb appears to advocate a vessel somewhat larger than the present destroyer and with some armor. If destroyers are designed of over 350 tons displacement they must be of inferior speed to the present ones (with the engines and boilers as at present designed), or else they must sacrifice a greater percentage of displacement to their motive power than is sacrificed in those of 300 to 350 tons. It has been pretty conclusively proved that for the same speed a smaller percentage of the displacement is required for the motive power in vessels of about 300 tons than in any other displacement until quite high figures are reached. So that, even without armor, larger destroyers must have less speed than those of the present size. It would require considerable armor to protect against 12-pounders, although comparatively light armor would be sufficient to keep out 1 and 6 pounders. The larger destroyers would lose much of the invulnerability of other torpedo boats due to their small size. The modern destroyer is a very wonderful weapon and admirably suited to the purposes for which it was designed, the destruction of torpedo boats, but must have its limitations as have other war-like instruments. The destroyer is not the first weapon that in the earlier stages of its development was expected by its ardent admirers to revolutionize naval warfare, that is, was to change completely the design of vessels fit to fight in the line, but it is surprising to find Admiral Colomb apparently arrayed on the side of those predicting a revolution. The torpedo and ram each had its day, each made its mark on the designs of the times. They created no revolution, but they did force modifications in design. The gun regained its ascendancy over the ram and torpedo, and the torpedo boat was limited by its vulnerability to operating in the dark or in thick weather, and by its endurance to operating at short distances from its base and in smooth water. Now arises the destroyer; it will have also its effect on the design of battle-ships; it will find also its limitations.

The battle-ship is not well suited to attack land defenses, and when well designed and of sufficient strength fortifications limit the area of a battle-ship's operations. Its area of operations may be limited also by light-draft rams, as they would prove most formidable at points where vessels of heavy draft were confined to navigating narrow channels. Torpedo-boats limit the area of operations of battle-ships, in that they become dangerous in narrow waters and near the coast, in darkness or thick weather. Submarine torpedo-boats may have also their limiting effect, in that they may make it dangerous for battle-ships to approach too nearly their bases even in daylight and in clear weather. In all cases the probable danger to the battle-ship may be greater than the possible good to be gained by the attempt. But in the struggle for the command of the sea the battle-ship still reigns supreme, because the battle for the supremacy must be fought at sea by vessels capable of sustaining themselves at sea. This is the broad lesson to be drawn from all history, from all experience both ancient and modern. The real difficulty that has confronted many students of naval history, and has served to mislead the advocates of special weapons, is the attempt to make general rules from particular cases. Seeing that many naval actions have happened near the land, they have exaggerated the importance of the narrow strip of water that adjoins the sea-coast, and have failed to realize that the force whose coast-line was attacked had been driven first by superior naval power from the high seas. It is this exaggeration of the importance of the strip of water adjoining the land that has served to introduce erroneous theories into both strategy and tactics. If Great Britain commands the ocean, France will benefit little from holding Toulon and Brest; and if France commands the Mediterranean, Gibraltar and Malta will be of little utility to Great Britain. It may be advisable, in order to terminate a war, to attack fortresses and occupy ports, but the most important work has been accomplished when the enemy has been driven from the high seas.

The fall of Sevastopol was insured when the Russian fleet was locked up in the waters protected by that fortress; and with all the glory gained by Todleben for his defense of Sevastopol, he might have served his country better had he retired from its walls, in place of furnishing by his energy and science a force sufficient

to hold it, and thus inducing Russia to diminish her resources by attempting to maintain a relieving army in the Crimean peninsula unaided by a fleet. In warfare on land fortresses have often been mistaken for the real objects of war, and the land forces, that otherwise might have marched to victory, wasted in their reduction. In naval warfare the same errors may be made. Farragut would never have occupied his present place in history had he wasted his resources by attempting to reduce the forts below New Orleans or Mobile.

If it be true that the field to be contested by warships is the high seas, then surely the battle-ship must be a vessel capable of keeping the sea—a sea-going vessel. Weapons may be designed that still further limit its area of action, blockades made more difficult and the protection of commerce less certain, and both may require stronger forces than at present; yet the force superior in strength and energy, if properly handled, must win. Our own war of the rebellion has been often quoted to show the difficulty of maintaining a blockade, and long lists of blockade-runners who have successfully eluded the blockaders are shown to prove how incomplete the blockade was; but does any one imagine that the efforts of the blockade-runners had any vital effect on the war? Can blockade-runners subvert armies, or the gains of a host of adventurers serve to replace the profits of legitimate commerce? Many were the English vessels that fell victims to our privateers in the war of 1812, and there were other enemies striking at the same prey, yet the commerce of Great Britain continued to increase while ours faded away.

The great advantage possessed by the destroyers, besides their small size, is the very high speed of which they are capable; but they can maintain this high speed for only a short time. They have a moderate steaming radius when proceeding at a moderate speed; but should they meet an enemy at sea, at a good distance from land, they would be unable to use their high speed unless they relinquished all idea of again reaching land. If they were met by an enemy near the end of, to them, a long voyage they would not have sufficient coal for high speed. And they could not remain off a port for any reasonable time and yet have sufficient coal to utilize the most important feature in their design—high speed. Again, destroyers must be small-sized vessels, and therefore must lose their speed rapidly, as compared with

large vessels, in a rough sea. In fact, except under unusual circumstances, a flotilla of destroyers must fall victims to large vessels on the high seas. Any one who has closely watched the history of the many destroyers now afloat must be convinced that they are frail boats, far too frail to allow of reliance being placed upon them in emergencies that require them to operate at a distance from their base. Weights have been so fined down that accidents are numerous, and the best of them require overhauling after a comparatively short experience of high speed. It would seem as if the function of the destroyer having been exaggerated so as to include the destruction of battle-ships on the high seas as well as the destruction of torpedo-boats, an attempt has been made to increase desirable qualities beyond the limits inherent in the design, and thus reliability and consequently efficiency have been sacrificed.

The battle-ship may be improved in several directions so as to make the destroyer's fate more certain; and yet the battle-ship may find its area of action still further limited by the advent of the destroyer, although employed within its legitimate sphere. But it would be a serious error for any maritime country and would be suicidal for Great Britain to neglect building battle-ships.

An inspection of the armament of various battle-ships will show a tendency of late years to decrease the number of the lighter guns carried. This is not an improvement, and an increase in calibre does not make up for a decrease in the number of shots per minute. It may be necessary, in view of the efficiency of the destroyer type, to increase the number of small guns, even if positions must be selected for them that would prevent them from being used under many circumstances, such as in a rough sea or when the larger guns were being employed—in fact, in positions where they would be used only to repel torpedo-boat attacks.

In torpedo-boats two types are gradually being settled upon by naval powers: the destroyer type and a smaller, slower type with a smaller steaming radius.

There is no settled type of cruiser, and each vessel appears to have been built to fill some pet idea of its designer. What is most essential is a type of vessel that will fill the place of the old sailing frigate and be the eyes of the battle fleet. There are

two special objects to be accomplished by vessels of such a type in connection with the battle fleet. One is to seek information of the enemy's fleet, and the other to mask the movement of their own fleet. The manœuvres of the great naval powers have been somewhat misleading on this question. Each side in the manœuvres has usually had good information as to the composition of the fleet of its opponent, so that a sighting cruiser would be satisfied often with reporting the amount of smoke, and at the most with counting the vessels composing the fleet. Whereas in real war it would be necessary under most circumstances to ascertain something of the real strength of the fleet, and draw sufficiently near to distinguish battle-ships from cruisers. Again, the attacking fleet has seldom used its cruisers as a real mask, but has dispersed them in search of the defending fleet. In real war there is more likelihood of hard fighting than has been shown by the manœuvres, and the ordinary so-called protected cruiser is but poorly fitted for hard fighting; too little room is left for skill, and when two cruisers of approximately equal strength meet in battle, both of them are likely to be lost to their fleets. Some side armor as a protection to their buoyancy is necessary, and yet they should be faster and have a greater steaming radius than a battle-ship. This it has been claimed will lead to excessive displacements and will make the cruisers almost, if not quite, as expensive as battle-ships; but this large displacement has been shown to be unnecessary, although armored cruisers have been enlarged to endeavor to fit them to fight in the line. Something near the ideal type, according to my idea, has been reached in the Argentine armored cruiser *San Martin*; and I believe such a vessel more nearly represents the frigate of old than any other type of vessel. Here the desired qualities have been secured with a displacement under 7000 tons.

CONCLUSION.

In what has gone before I have endeavored to show that for purposes of defense alone we must maintain a sea force sufficient to hold command of the sea at certain localities, such as will prevent an enemy from proceeding against our coast or commerce. That the battle which will decide the fate of our coast with its great ports and numerous lines of communication will be fought on the sea and by sea-going battle-ships. That while

our force may not be sufficient to meet the enemy unaided, it should be sufficient to meet him, with reasonable chances of success, when aided by certain coast fortifications located at the advance naval bases. The entire problem of coast defense must be considered as a whole, so that the proper part may be allotted to each kind of force, naval and military, both mobile and immobile. Thus while our battle fleet may be unable to hold its own on the high seas and may be forced to seek the narrow seas adjacent to our coast, that here it may receive such reasonable support as to prevent the enemy from undertaking any important operations, other than seeking to reach conclusions by attacking our fleet at a point selected and fortified by us. With such a force and with judiciously placed fortifications, and a compact but active torpedo flotilla, we should be able to prevent military expeditions from landing on our coast, to prevent the enemy from blockading our ports and to protect our coastwise vessels.

There is no law of strategy by which, if followed, we can hope to protect our interests with a few battle-ships, but there is one, which if we follow will enable us to make a strong defense, with a reasonable fleet, against any of the great naval powers without attempting to enter into a race of construction with the nations of Europe. We need many carefully placed fortifications to aid the fleet, but unless judiciously armed and the locations properly selected our coast and harbor fortifications may become more expensive and less efficient than if all the money were devoted to floating defenses.

Already our interests are closely bound up with the other countries of the Western Hemisphere, and it requires no prophet to foretell that our merchant fleets will once again visit all portions of the globe. So that our interests are now growing beyond the waters washing our coasts, and our Navy will soon be expected to afford protection to a considerable merchant marine in all parts of the world. To do this effectively we must have, also, coaling stations so protected as to defy raiders. In fact we cannot avoid our responsibilities as one of the family of nations. We can avoid entangling alliance and should refrain from assuming the attitude of an armed ruffian, but if we are to remain prosperous and if we are to conserve our liberties we must become powerful, daring to do right and only fearing to do wrong.

Avoiding aggressive war, but not so dreading war as to invite aggression from the armed bully, or so fearing to assert the truth and to stand up for justice as to drift into an armed conflict that might have been prevented by an assertion of our strength in the outset.

What boots it at one gate to make defense,
And at another to let in the foe?

(Discussion, p. 127.)



after propeller is keyed to the main shaft, and the forward propeller to a sleeve or hollow shaft, free to move on the main shaft. By means of bevel gears on the main shaft, and on the forward end of the sleeve, suitably arranged, the propellers revolve in opposite directions.

The torpedo is maintained at constant depth by horizontal rudders, and on a straight course by vertical vanes set at an angle predetermined by experiment, or by movable vertical rudders controlled by the Obry gear.

These torpedoes are a decided improvement, in the matter of speed and certainty of work, on the earlier type of shorter torpedoes.

The *war head*, of sheet phosphor-bronze, is charged with approximately 220 pounds of wet gun-cotton, and is closed at its base by a bronze bulkhead. In the bulkhead is a moisture tap, through which distilled water may be poured when necessary to make up possible loss of weight by evaporation.

Soldered in the forward end of the war head is the primer case, of brass, in which is inserted the dry gun-cotton primer.

The wet gun-cotton is inserted in a series of discs, a sufficient number of them, counting from forward, being pierced through their centers to receive the primer.

The primer consists of a series of small cylinders of dry gun-cotton in a metal case. The forward cylinder is pierced to receive the detonating primer, containing fulminate of mercury, and capped with a percussion cap.

The *exercise head*, of steel, is ballasted for exercise by filling it with fresh water.

The *war nose* screws into the forward end of the primer case. A traveling sleeve has a thread cut inside, throughout its length, and in this thread works a traveling nut. This nut is turned by a screw fan, receiving its motion by its passage through the water. The nut is screwed back by the action of the fan until it rests against the firing pin. A shearing pin holds the latter in place, and as the nut continues to revolve the sleeve moves out, carrying the fan with it, until the square shaft of the fan is pushed out clear of the nut. The fan then revolves freely. When the torpedo strikes the target, the fan, nut and sleeve are driven in, shearing the shearing pin and driving the firing pin against the percussion cap.

The *air flask* is a hollow, forged steel cylinder, slightly tapered at the ends, with dome-shaped heads screwed and soldered in each end. A strengthening band, left on the inside surface in boring, is tapped from the outside for three screws for attaching the guide stud. Over a hole in the after head is bolted and soldered the body of the charging and stop valves.

Immersion Chamber.—This chamber contains the immersion regulators. It is just abaft the air flask and is riveted and soldered to it. The after end is closed by a bronze bulkhead.

The purpose of the mechanism in this chamber is to control the horizontal rudders after launching, so as to bring the torpedo to a predetermined immersion, and keep it there during its flight. This is accomplished as follows:

A small compartment in rear of the immersion chamber has free communication with the water outside through several apertures in its walls. The pressure of the water, due to depth below the surface, acts against a piston, but the water is prevented from getting behind the piston by a circular diaphragm of thin rubber. The motion of this piston, due to different pressures at varying depths, is communicated to the horizontal rudders by means of rods in such a manner that when the torpedo is below its plane of immersion the increased pressure will elevate the rudders, and when it is above, the decreased pressure will depress them.

When the torpedo is in its plane of immersion the piston is kept in mid-position by an equilibrium between the pressure of the water and the tension of a spiral compression spring.

Hydrostatic Piston Testing Attachment.—This attachment is for the purpose of testing the action of the hydrostatic piston on the rudder. It obviates the necessity of the bent lever used with the 3.55 m.-45 cm., Mark I, torpedoes.

It consists of a composition jews-harp link encircling the tube of the hydrostatic piston spring, and fitted at its upper extremity with a collar that fits over the end of the socket post, under the adjusting nut. The lower end of the link is fitted with jaws, by which it is attached to the horizontal arm of a small bell crank lever pivoted on the bulkhead under the tube of the hydrostatic piston spring. The upper arm of the bell crank is connected to the hydrostatic piston by a ball and socket joint. When the adjusting screw is turned by the wrench in the direction that releases the tension of the hydrostatic piston spring, the adjusting

nut travels downward, bears upon the jews-harp link, and through the bell crank lever forces the hydrostatic piston forward its full travel.

Pendulum.—A pendulum, which swings in a vertical plane passing through the axis of the torpedo, acts to maintain the torpedo in a horizontal plane. If the hydrostatic piston is acting on the rudder to steer the torpedo up or down, when the torpedo has inclined three degrees above or below the horizontal plane the pendulum swings towards the end of the torpedo that is lowest and counteracts the action of the piston on the rudder. The combined action of the piston and pendulum is transmitted by a system of levers and connecting rods to the steering engine, and thence to the rudder, to maintain the torpedo in the horizontal plane at the set depth.

Engine Room.—Next abaft the immersion chamber comes the after body, containing two compartments; between them is a bulkhead. The joint is made tight by a rubber gasket. To this bulkhead the propelling machinery is secured. The engine room contains the main engine and oil cup, the valve group, the sinking and retarding gear, the steering engine, and the locking gear.

The *Whithead torpedo engine* consists of three cylinders, fixed radially about the propeller shaft with their axes 120 degrees apart. Within the circular enclosure, at the junction of the cylinders, the main crank is free to revolve, and receives its impulse from the piston of each cylinder in succession. The compressed air is admitted behind the piston and evacuated in proper order by means of three slide valves, each working in a separate chest on the forward face of each cylinder, but all regulated by a single cam, keyed to the main shaft.

The Depth Index.—The depth at which a torpedo runs is adjusted by means of the depth index.

An adjusting screw, with a square socket in its upper end, is supported at its lower end in a socket post. A nut travels along the thread of the adjusting screw when turned. A fork at one end of a bell crank presses against a collar on this nut, and a fork at the other end against a compression spring acting against the hydrostatic piston. The lower end of the spindle of the depth index fits in the square socket of the adjusting screw, and has a square socket in its upper end, in which fits a male socket wrench, used in setting the depth index. The spindle carries a worm

which gears into a vertical wheel having graduations around a part of its circumference for 5, 10, 15 and 20 feet immersion. A cap screws down over the worm wheel, having a central hole through which the figures may be seen when the worm wheel revolves. A smaller cap screws down (using a square male socket wrench) over the spindle of the index, to keep it in place and to prevent water from entering the immersion chamber.

The desired immersion, in feet, will be obtained by turning the depth index spindle, with the socket wrench, until the figure indicating this immersion is seen on the worm wheel through the central hole in the cap over the wheel.

The *steering engine* is operated by air at the working pressure of the main engine, and transmits the action of the immersion mechanism to the rudder.

The combined action of the pendulum and hydrostatic piston is transmitted by a rod to the steering engine valve, which controls the action of the steering engine, and thence the position of the horizontal rudder.

There is no valve star used in this torpedo with the steering engine. One arm of the bell crank is pivoted to the forward end of the valve stem of the steering engine, the other arm pointing forward. A rod, connecting with the hydrostatic piston and pendulum, is connected with one arm of another bell crank, the other arm of which points aft and is pivoted to the elbow of the bell crank pivoted to the valve stem. A screw (called the valve adjusting screw), with a square head, passes through a collar in the forward end of the after bell crank, its end screwing in the forward arm of the forward bell crank. A spring around this screw tends to keep the forward ends of the bell cranks apart. Screwing down on the adjusting screw compresses the spring, brings the two forward arms of the bell cranks closer together, practically lengthens the valve stem, and puts the rudder down. Turning the valve adjusting screw in the opposite direction shortens the valve stem and puts the rudder up.

The valve adjusting screw is usually set to give one more division of down-rudder than of up-rudder, to give plenty of scope of down-rudder to steer the torpedo down, as it becomes lighter, on account of the air being used to propel the torpedo. The divisions are marked on the face of a vertical scale which fits, by a collar, over the hollow propeller shaft, and, by a slot, to the

upper vertical tail piece. A horizontal pointer is clamped to the rudder and moves over the scale, showing the number of divisions of up- or down-rudder.

The forward end of the steering rod acts against a spiral spring. When, at the end of the run, air is cut off from the steering engine, this spring forces the steering rod forward, puts the rudder up, and brings the torpedo to the surface.

The *reducing valve* is balanced between the pressure of a spring tending to raise it from its seat and the pressure of air on top of it tending to seat it. The object is to regulate the pressure of air admitted to the engine. A crank is used to screw down a plug which compresses the spring. The number of turns to give this regulator plug for highest speed, for a run of 800 yards, is given on the record sheet of each torpedo.

The *starting lever* admits air to the reducing valve, from whence it passes to the main engine. Before the torpedo is launched the lever lies flat along the upper surface of the shell, the end pointing forward. When the torpedo is launched the starting lever catches under a tripping latch, in the tube, and is thrown back.

The *distance gear* provides means for automatically closing the reducing valve, and thus stopping the engines after the torpedo has run a predetermined distance.

In general terms the action of the distance gear may be described as follows: A spindle with a square head is accessible from the outside of the torpedo, through a hole, and may be turned by a socket wrench. The spindle has a worm on its lower end, which engages the teeth of a wheel, with cogs around a portion of its circumference, called a distance sector. One turn of the spindle revolves the sector one tooth, and the number of turns for a run of 800 yards is given on the record sheet of the torpedo.

A small wheel with a sector cut from its circumference, called the friction cam, lies flat along one face of the distance sector. It has a motion of rotation which is limited in one direction by a pin, projecting from its periphery, coming in contact with a stud projecting from the face of the sector. A return spring, connected to the axle of the cam, keeps the pin in contact with the stud in setting the sector, and causes the cam to follow the sector in its rotation when the sector is set.

The flat ring (with two small holes in its surface) next to, and just inside of, the setting bar, is the setting bar clamp nut.

When the rudder is locked the valve stem is held rigidly by a long locking arm projecting from a ring, called the locking ring. A shorter arm projects from the opposite side of the ring, and is called the short locking arm. The two arms bear against the face of a flat, circular flange (called the locking flange), cast on a long sleeve (called the flange sleeve), which fits over a rigid spindle. The ring is pivoted midway between the arms on screws which screw into the locking ring carrier. This is a thick cylinder, underneath the locking flange, which slides on a rigid spindle. A circular score is cut in the face of one end of the cylinder, in which a pin, rigidly attached to the locking flange, moves, and thus limits the motion of rotation of the flange around the spindle. The face of the other end of the cylinder has a segmental score planed out, which is the bearing surface on the cam on one end of the rudder index dial sleeve.

The flange is cut away in two diametrically opposite sectors, each sector being about one-sixth of the circumference of the flange, and cut deep enough towards the center to permit fore and aft motion of the arms of the locking ring, when the locking sleeve and flange are revolved to the proper position.

The flange and its sleeve also slide on the same spindle as the locking ring carrier, the flange and carrier being held to position by a spring (around the spindle and inside the sleeve). Next to the spring is a washer, and next to the washer the ratchet bar sector arm; all held in position on the spindle by a nut screwed on it next to the ratchet bar sector arm. This arm pivots around the spindle, and supports the sector, of which it is part. Two deep slots are cut in the flange sleeve (diametrically opposite), and the ratchet bar sector arm fits in these slots snugly so that the motion transmitted by the ratchet bar to the ratchet bar sector is transmitted by the latter to the flange sleeve and flange, to release the locking ring, and thus release the steering engine valve rod to action.

In locking the rudder the bevel gear is turned by a wrench, with its two pins inserted in the slots of the sleeve. This draws the ratchet bar down. Its teeth engage with those of a small pinion. This pinion receives a motion of rotation from the engine when running, moves the ratchet bar up again, turns the

locking sleeve until the arms from the ring are opposite the cut out portions of its rim, when the valve stem is unlocked, and the steering engine free to act.

Rudder Index.—This regulates the position (up, down, or horizontal) in which the rudder is locked during the time the locking gear is in action. This regulates the depth of the initial dive of the torpedo.

The dial of the rudder index is on the left side of the torpedo. It is circular and graduated to 32 divisions on each side of the zero mark, and is turned by a wrench. It is clamped by the inner clamp at the center of the index, the outer clamp being for the locking dial.

The dial is on the face of a long sleeve, the other face of which is a cam, bearing against a sleeve (called the rocking ring carrier) on which pivots the locking ring, with two arms.

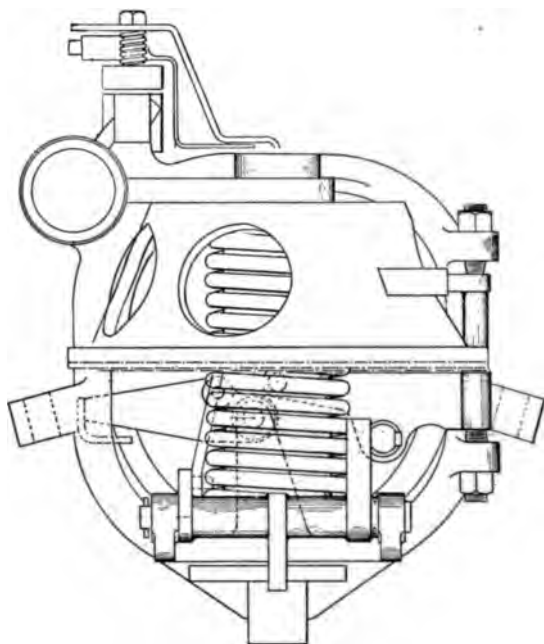
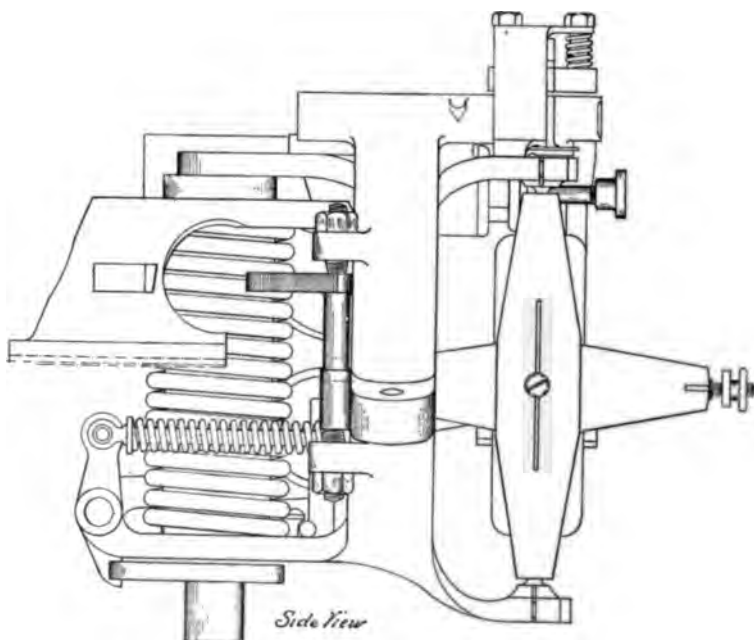
The valve stem of the steering engine being locked by the locking gear, when the dial of the rudder index is revolved with a wrench, the valve stem is moved out or in, by the cam on the rudder index dial sleeve moving the locking ring carrier, and with it the locking ring, the long arm of which moves the valve stem. Turning the dial to the right puts the rudder down, and to the left puts it up. Briefly, the rule is, *the rudder moves in the same direction that the dial is turned.*

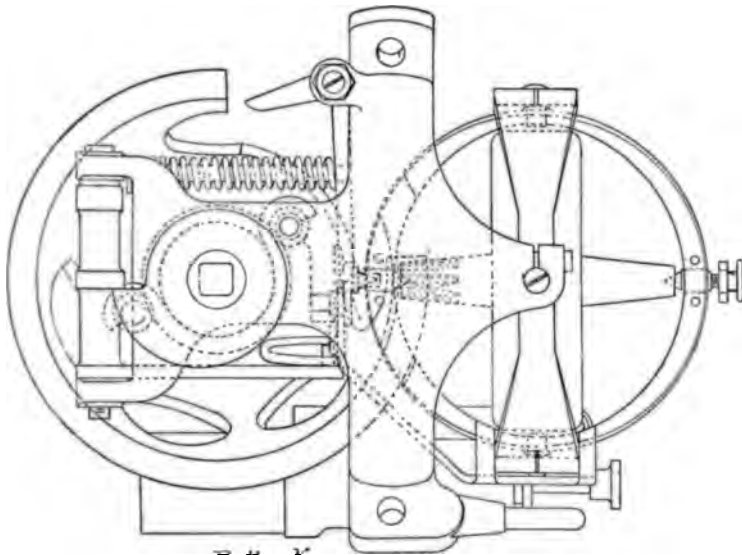
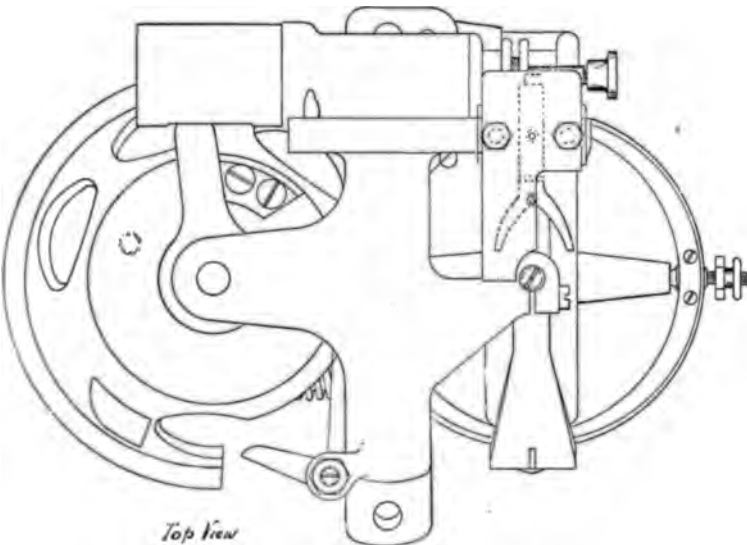
Obry Gear.—The object of the Obry gear is to keep the torpedo on a straight course during a run.

It is carried in the after compartment of the after body, just abaft the bulkhead to which the main engine is secured. It is put in place, and may be removed, through a door in the shell of the torpedo on the under side. Its frame is secured by square-headed screws to supports riveted to the shell of the torpedo.

The Obry consists, essentially, of a gyroscope controlling the motion of the valves of a steering engine, which operates two rigidly connected, vertical rudders, working in the forward top and bottom blades of the torpedo.

The gyroscope wheel, of Tobin bronze, is three inches in diameter and weighs $1\frac{3}{4}$ lbs. Its axis is in a fore and aft direction in the torpedo. The axle is fitted with tool steel female centers, supported on male centers screwed through the inner ring. The inner and outer rings are fitted with steel female centers and supported by screws the inner ends of which form the male centers.

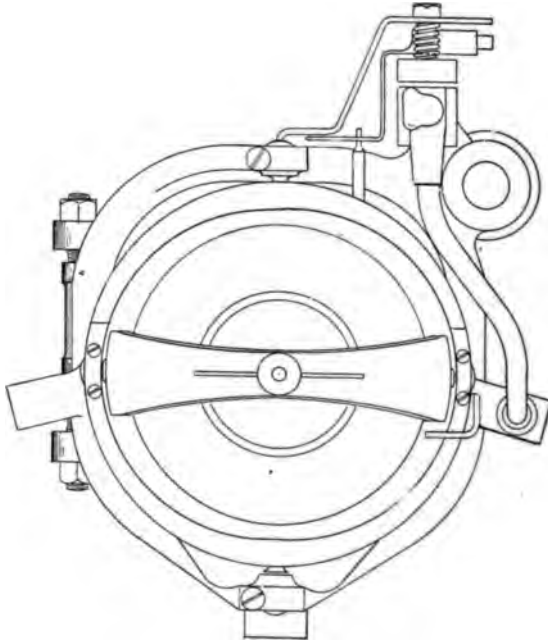
*Forward End View**Side View*

*Bottom View**Top View*

When the wheel and rings have been adjusted these screws are locked by locking screws. The after centering screw of the axle of the gyroscope wheel projects beyond the inner ring, is

threaded, and carries a nut and jamb-nut, which may be screwed towards or from the gyroscope wheel as a counterbalance.

Screwing the counterbalance out causes that end of the axle of the gyroscope wheel to move to starboard in the torpedo,



After End View

which will cause the torpedo to run to port; screwing the counterbalance in towards the gyroscope wheel will cause the torpedo to run to starboard.

The screws through the inner ring, supporting the gyroscope wheel, may also be used for adjustment by moving the gyroscope wheel bodily in the direction of its axis inside the ring.

The outer ring has a small steel pin projecting outwards, which actuates a steel yoke (called the valve arm) and gives the valve motion to the rolling valve of the steering engine. The valve seat (called the valve plug) is outside of the valve (which is cylindrical and hollow) and is, in shape, a hollow, truncated cone, which may be moved within small limits around the valve by horizontal adjusting screws. Air is taken from the valve group,

How

and, after passing through a reducing valve (which reduces the pressure to about 150 lbs. per square inch), passes around the valve, through the valve plug and to the steering engine. It exhausts through the valve plug and valve into the after body.

The adjusting screws of the valve plug are used to correct deviation of the torpedo either to right or left of a straight course. One screw must be slacked up before the other can be screwed in. Then screwing in the second screw draws the end of the valve plug into which it screws towards that side, and causes the torpedo to run towards the side of the first screw (the one slacked up). That is, *the torpedo runs in the direction in which the screws are moved.*

The motive power of the gyroscope wheel is a stiff steel spring, wound by a key through a hole in the shell of the torpedo. The spring, when released, turns a cogged sector (called the impulse sector), the cogs of which mesh with cogs on the forward axle of the gyroscope wheel, over 276 degrees of the sector, and thus gives the gyroscope wheel a high speed of rotation. A sector of 84 degrees is cut from the impulse sector, which allows the gyroscope wheel to continue its rotation after the cogs of the remaining 276 degrees of the impulse sector have all passed the cogs on the axle of the gyroscope wheel.

By suitable connections with the starting lever of the main engine the gyroscope is centered, before winding it up with the key, by putting the starting lever down flat along the shell of the torpedo. After winding the Obry, throwing back the starting lever releases the impulse spring, which then spins up the gyroscope wheel.

The tail of the torpedo consists of the part abaft the after body, comprising the gear box, the tail tube, and the frame of the tail. The latter consists of a forward and after cone, each carrying a pair of vertical flat blades and a pair of horizontal ones. The forward and after blades are joined stiffly together by rails. On the upper edge of the top rail is a guide which enters the guide slot in the tube in launching.

The gear box carries the bevel gears by which the motion of the main shaft is transmitted to the outer tubular shaft in a contrary direction. The propellers, of steel, are two-bladed and are carried in tandem, the forward one right-handed, on the outer tubular shaft, and the after one left-handed, on the main shaft.

The horizontal rudder, of steel, is carried at the rear end of the

tail, and is connected with the steering rod by a series of levers carried around the propeller on the lower, vertical, flat blades and lower rail.

The vertical vanes are set when the torpedo has its trial. They are pivoted at their forward ends, and can be swung on their pivots, to starboard or port, to give permanent rudder effect.

The propeller shaft is in two sections, the after one fitting as a sleeve over the forward one, to which it is held to revolution by four feathers and slots.

The tail may be removed by disconnecting the two steering rods and withdrawing the tail joint screws. When the Obry steering rod is disconnected, enter the screw in the locking hole of the tail cone to lock the rudder spindle yoke, to hold the rudder amidships. In removing or putting in the horizontal rudder rod, take out the screw and the rod will more easily pass through the hole for it in the spindle of the vertical rudder.

In putting the tail on the after body see that the marks on the two shaft sections coincide, so that the engine can be set to start without sticking on the center.

The vertical rudders are carried in the forward vertical flat blades, and are rigidly connected by a yoke around the starboard side of the propeller shafts. The steering rod from the Obry steering engine is connected to the yoke.

Preparation, on board ship, of the Mark I 5 m.-45 cm. Whitehead Torpedo for a Run.

Start air pumps to charge accumulators.

Put yoke on propellers.

Close starting lever.

Enter head of torpedo in tube.

Put rope sling under after body, raise it from truck, at same time elevating breech of tube as necessary for torpedo to clear truck.

Place loading staff against end of propeller shaft and shove torpedo into tube, with guide stud just entering guide slot.

Remove charging valve plug.

Screw in valve of charging pipe.

Open stop valve.

Open valves in air pipe between separator and torpedo.

Examine torpedo for leaks.

Try hydrostatic piston to get the throw of horizontal rudder due to the action of the piston alone.

To do this see the yoke on, level torpedo, give two or three turns to regulator, raise water tripper, raise starting lever; then work depth index with a socket wrench, screwing it up and down between graduations 0 and 5. This will give a *total* throw of the rudder of from $3\frac{1}{4}$ to $4\frac{1}{2}$ divisions, and in all cases should give $\frac{1}{4}$ division more down-rudder than up-rudder. In case it does not give this much more down-rudder, lengthen the steering engine valve rod by turning the valve adjusting screw to the right, by means of a small wrench inserted through a hole in the shell of the after body, just forward of the locking dial.

This adjustment is important, and if it cannot be made by the valve adjusting screw, the steering engine rod will have to be lengthened or shortened (depending upon whether down- or up-rudder is required to give the $\frac{1}{4}$ division more down-rudder desired), by screwing the steering engine rod out or into the coupling just abaft the steering engine.

Try Steering Engine.—To do this admit air to steering engine by lifting the starting lever slightly. Insert a small socket wrench through hole in shell of torpedo, place its end over the end of the valve adjusting screw, and move the steering valve rod as far forward, and then as far aft, as possible. This should give four divisions down-rudder and three up-rudder.

Set distance gear by means of socket wrench inserted through a hole in the engine-room door, fitting over the square upper end of the adjusting spindle. The record sheet gives the setting for 800 yards range. See that the friction cam pin bears against the distance sector stud.

Set the Regulator.—Insert the crank with a square head in the square socket of the head of the regulator plug. Screw the plug up until its upper face is flush with the top of the regulator body. The record sheet gives the number of turns to be given to the plug to obtain maximum speed for an 800 yard run.

To get the best speed of the torpedo the pressure in the air flask should be reduced from 100 to 105 lbs. per 100 yards run. If enough air is not used to reduce the pressure this amount, screw the regulator plug down a little more.

The final pressure in the air flask after a run is obtained by unscrewing the charging valve plug and screwing the valve end

of the pipe of a pressure gauge in its place. The reading of the gauge gives the final pressure.

The actual final pressure at the instant of the finish of a run is from 50 to 125 lbs. less than the reading, on account of the lower temperature of the air at that instant, due to its rapid expansion during the run.

Set the Locking Dial.—The locking dial is set to lock the steering engine valve rod, to prevent the rudder acting while the torpedo is gathering its headway.

To set it, unclamp, with the locking wrench, the clamp nut (first one from the center) of the setting bar.

Turn the setting bar around the proper number of divisions (each division corresponds to a run of about 15 yards from the ship, counting from the zero division).

Set up the clamp nut with the wrench.

Turn the locking dial sleeve to the left, with the wrench, until the pins of the latter bring up against the setting bar, which completes the locking for the desired distance.

Set the Rudder Index.—To give up, down, or horizontal rudder during the time the rudder is locked.

Unclamp, with the locking wrench, the clamp nut (center one) of the rudder index dial.

Turn the dial (the outer graduated one), with the wrench; to the right for down-rudder, or to the left for up-rudder. (About twelve divisions on the dial are equal to one division on the rudder.)

Set up the clamp nut with the wrench.

Set Depth Index.—To fix the depth at which the torpedo will run.

Put the socket wrench in the socket of the depth index spindle and turn the wrench until the depth, in feet, desired is shown by the figure stamped on the worm wheel, as seen through the central hole in the cap over the wheel.

In assembling the torpedo the reference point of adjustment of the depth index is for five feet immersion of the torpedo. The adjusting screw is turned until the after edge of the lower arm of the forked bell crank coincides with a line cut on the side of the tube for the hydrostatic piston spring, marked 5, which gives the compression of the spring that will balance the water pressure on the after side of the piston at a depth of five feet. The depth index is put in place with the figure 5 showing through the cen-

tral hole in the cap, when the after edge of the forked bell crank coincides with the line cut on the tube for the hydrostatic piston spring.

Oil Cups.—Fill valve group oil cup, gear box oil cup, engine room oil cup, and oil after bearing. The oil in the valve group oil cup is for packing, and is forced out by pressure of air.

See all drain plugs in the after body closed.

Close valves in charging pipe, unscrew charging pipe, and screw in plug.

See that the starting lever is down, and then wind up the Obry.

Lift firing lever and put in safety pin.

Raise water tripper.

Raise tripping latch and shove torpedo in tube.

Take off yoke and see propellers turned until notch on end of shaft is S. S. E. (This is to prevent engine being on center, as the cylinders cut off at $\frac{1}{3}$ stroke.)

Work firing lever up and down to see that stop pin is not jammed.

Close door of tube, load, prime, point, and fire.

Obry Gear.—The action of the Obry gear upon the torpedo is to cause it to make a series of short curves, but to keep a mean straight course, varying but little from the line of sight. If the curves are long, or if the general direction taken by the torpedo is to the right or left of the line of sight, the Obry should be examined to see if it is properly adjusted.

In testing or adjusting the Obry on board ship, the ship's head should remain on the same compass course, for if the ship is swinging, the change in azimuth will have the same effect upon the result as though the torpedo had deviated from its course by the same amount as the ship has swung.

To Test the Obry while in the Torpedo.—See the starting lever down, raise the water tripper, and put the yoke on the propellers. Put the transporting strap on, and sling the torpedo so it may be swung in azimuth. Wind the Obry. Raise the starting lever, which starts the gyroscope wheel spinning by releasing the impulse spring. Swing the tail of the torpedo gently from side to side, and note the angle, or arc, through which the tail moves when the vertical rudders move from one side of the torpedo to the other. If the Obry is working properly the rudders should move from one side to the other when the tail is swung through an arc of one degree ($\frac{1}{2}$ degree each side of the central position);

the extreme limit within which it is necessary to move the tail to work the rudders might very properly be considered as not more than 3 degrees of arc ($1\frac{1}{2}$ degrees each side of the central position). It should, however, be less than this.

Continue to swing the torpedo to the right and left for four or five minutes, and notice if the limiting points of the arc through which the tail is swung remain constant, or if it is necessary to swing the torpedo a little farther to the right or left each time. If such is the case, and the ship is steady, then the gyroscope wheel is probably not keeping in the same plane as it should. It will therefore be necessary to adjust the Obry.

To Adjust the Obry Gear.—Take out the screws of the Obry door and remove the door. Unscrew the holding-down screws of the Obry, with a socket wrench, and lift the Obry out of the torpedo. Put it in the frame of the adjusting stand and screw in the holding-down screws.

Swing the starting lever (on the adjusting stand) around in the direction the hands of a watch move as far as it will go.

Wind the Obry, noting that the impulse sector meshes properly with the teeth on the gyroscope axle.

Have a watch ready to note the duration of the time the Obry will run. (They run from ten to eleven minutes, when adjusted in the shops where made.)

Trip the impulse spring by moving the starting lever back in the opposite direction to the motion of the hands of a watch, seeing that it remains in the position to which moved and does not fly back.

Set a pointer on the stand, close to the end of the center on which the counterbalance is screwed, so that its motion (if any) may be carefully noted. (This is the after center on which the gyroscope wheel turns when the Obry is in the torpedo.)

If this center moves to the left (against the hands of a watch) the counterbalance is too heavy, and must be screwed towards the ring.

If the after center moves to the right the counterbalance is not exerting weight enough on the wheel, and must be screwed out.

If the horizontal motion, to right or left, of the after center can not be overcome by moving the counterbalance in to the ring, or out to the end of the screw upon which it is screwed, then the gyroscope wheel itself will have to be moved in the same direc-

tion. To do this slacken the clamp screws of both centers, unscrew one center about one-quarter of a turn, then screw the other one in carefully the same amount. The wheel will be found very sensitive to this adjustment. See that the wheel turns freely on its centers, then set up the clamp screws.

Wind up the Obry and try the running of the wheel again. Continue the operation until there is no horizontal motion of the centers of the wheel, and, of course, of the wheel itself.

If the centers of the gyroscope wheel have a vertical motion, after the horizontal motion has been overcome, it probably indicates that the gyroscope wheel is too near the ring-bearing of one of its centers, and too far away from the other one. Moving it back to the proper position would introduce a horizontal motion of its centers. The vertical motion would probably not interfere with the proper action of the Obry, however (unless the torpedo rolled), except in cases when it was so marked that the wheel had turned up to a position where the gyroscopic action was interfered with before the torpedo had finished its run.

The vertical motion might be overcome by moving the wheel in the direction of its centers until in the proper position, and then filing from the heavier side of the ring.

The wheel is nearer the ring-bearing of that center which has a vertical motion upwards when the wheel is running.

Having adjusted the gyroscope so the centers of the wheel do not move in azimuth while the wheel is running, make the air connections and turn on a pressure of about 150 lbs. on the steering engine.

Wind up and start the Obry, and then work the frame of the adjusting stand back and forth to get an indicator diagram. This will show the action of the rolling valve of the steering engine. Excellent cards have been taken by moving the frame through an arc of one degree (one-half degree each side of the center).

If the card shows that the torpedo would have a tendency to run either to port or starboard of the line of sight (through the action of the Obry), counteract this tendency by setting the valve plug by the adjusting screws of the valve.

One screw must be slacked up before the other can be screwed in.

The torpedo will run in the direction in which the screws are moved.

To Remove the Gyroscope Wheel.—The centers of the wheel may

be more readily examined and kept free from rust, if the wheel is kept dismounted and in the compartment provided for it in the Obry gear box. The wheel should always be dismounted for transportation. To dismount it come up the clamp screws of the counterbalance centers, but do not disturb the other center of the wheel, in order that the wheel may be put back in the same position in the ring.

Jam the two nuts of the counterbalance tightly together, holding the hexagonal-headed nut with a wrench, and screwing the jam nut tightly against it with the fingers. Then grasp both nuts with the thumb and forefinger, and by turning them to the left (and with them the center on which they are screwed) the center will screw out until clear of the axle of the gyroscope wheel, when it may be removed.

Impulse Spring.—Should the impulse spring become weak, tauten it up as follows: Take out the screws in the impulse sector stop, and take off the stop. Give the impulse spring one complete turn with the winding key, and holding it in this position by the key, put on the stop again. Be careful to keep the fingers out of the holes through the impulse sector or they might be cut off by the sector in case the key should slip.

To Assemble the Obry Gear.—Clean out steering engine cylinder with clean, oily waste.

Put in cylinder head between steering engine and air cushion cylinders, and set it up tightly, using winding key inserted through steering engine cylinder.

Oil piston and piston rod of steering engine and put them in.

See that the packing of the stuffing box of the steering engine is in good order and in place. For packing use a piece of 2 strand lamp wicking, about nine inches long, dipped in best tallow.

Use an oiled linen paper washer under both cylinder heads.

Screw the outer cylinder head in tightly with flat open-end hexagonal $\frac{1}{2}$ inch wrench provided.

Set up on the stuffing box with thumb nut, so that the piston works moderately tight.

Put in the split pin holding the bonnet of the stuffing box from turning.

Put in the air cushion pistons, the one with the screw hole in it being outboard.

Put the cushion lever on the impulse sector.

Put the impulse sector in place, and insert its shaft to see that they fit properly.

Put on the impulse sector stop.

Take out the shaft, and put on the impulse spring.

Put in screws holding the end of the impulse spring.

Put sector and spring in place in frame, and put in impulse sector shaft.

Secure ends of spring to screws.

See that the impulse sector stop is on the right side of the lever for cushion piston.

Screw the outer ring centers in place until they are just through the frame.

Secure inner ring in outer one by its centers, balancing it neatly.

Put rings in frame and screw in outer ring centers.

Put in the centering lever or clutch.

Put in vertical rock shaft for centering gyroscope wheel.

Put gyroscope in rings, balancing it neatly.

Insert a block of wood about an inch and one-half thick between the impulse sector and frame, to bring the sector into position to mesh with the teeth on the axle of the gyroscope wheel.

Turn up the clutch of the position holder by hand until it bears against the inner ring, to get the rings at right angles to each other. Then move the vertical rock shaft bodily up or down as necessary, by means of the screws at its ends, until the centering stud enters the socket in the end of the gyroscope wheel. When in the right position, lock the rock shaft against vertical motion by setting up the locking nuts at the ends of the shaft.

Examine the meshing of the impulse sector and teeth on the axle of the gyroscope wheel, to see that it is done satisfactorily, and see that the clutch brings up against the inner ring, to bring it in proper position for the centering pin on the vertical rock shaft to enter the socket in the center of the gyroscope wheel.

Put in the clamp screws of the outer ring centers.

Put in the horizontal rock shaft, the double-acting rock shaft spring and shaft, and the split pin in the end of the shaft.

Hook up the auxiliary horizontal rock shaft spring (a piece of brass wire) and put in split pin.

Clean rolling valve with oily waste, and wash it off with a blast of air from the charging pipe.

Put in the valve plug, put on the valve arm, holding down springs, holding down plate and nuts. Put in the valve arm holding screw, seeing that the valve is on the center, with the valve arm in mid-position, before setting up the screw tightly.

TOOLS USED WITH OBRY GEAR, WITH THE NAMES,
DIMENSIONS, AND USES OF EACH TOOL.

TOOL No. 1.

Name.—Flat, open-end wrench (double).

Use.—(Hexagonal end, $5/16$ inch) with hexagonal-headed nuts, holding down valve-guard plate on top of valve.

Use.—(Square end, $9/64$ inch) with valve-plug adjusting screws, and securing screw of valve arm.

TOOL No. 2.

Name.—Flat, open-end wrench (double).

Use.—(Hexagonal end, $3/8$ inch) with check nuts of vertical rock-shaft pivots.

Use.—(Hexagonal end, $17/32$ inch) with cylinder head of steering engine.

TOOL No. 3.

Name.—Small screw-driver (double end).

Use.—($1/8$ inch end) with inner ring clamping screws, and clamping screws of gyroscope wheel pivots.

Use.—($3/16$ inch end) with all pivots of gyroscope, and rock-shaft pivots.

TOOL No. 4.

Name.—Small screw-driver (double end).

Use.—($1/4$ inch end) with door-plate screws and frame pivot locking screws.

Use.—($5/16$ inch end) with screws for stop on impulse sector.

TOOL No. 5.

Name.—Combination winding key and socket wrench.

Use.—Winding key (square head, male, $11/32$ inch, one foot long, stem 6 inches long) winds up Obry; also screws (in or out) the partition between the steering engine and air-cushion cylinders, by inserting wrench (through steering-engine cylinder) in square socket of partition. (This partition forms a cylinder head common to both steering engine and air-cushion cylinders.)

Use.—(Square socket wrench, female, $7/32$ inch) with holding screws of Obry, securing it to its supports in the torpedo, or box.

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SOME PRACTICAL NOTES ON BATTLESHIPS.

From a seaman's practical standpoint, *i. e.*, as seen by "the man behind the gun."

By Lieutenant E. W. EBERLE, U. S. Navy.

Our battleships of the Oregon class were designed, built and given their trials on a theoretical draft of twenty-four feet: a draft which has no practical significance and upon which they have never gone to sea since being commissioned. With her coal, stores and peace-time supply of ammunition on board, and ready for a cruise, the Oregon has a draft of more than twenty-six feet, displacing more than 11,500 tons, and her armor belt is very little above water. Thus when ready for sea, with the main armor belt submerged, these battleships are very little better off in the way of above-water protection than armored cruisers, their only protection above water being the four-inch armor belt. Granting that these ships could go into action with very little coal in the bunkers so as to get the full benefit of the armor belt, and in comparatively smooth water, even then a few shot holes at the water line forward and abaft the armor belt would soon fill enough water-tight compartments to cause the ship either to turn over or to heel to such an alarming extent as to interfere with the working of the guns and to submerge the armor belt completely. As the all-important object is to keep the ship on an even keel so as to fight the guns most effectively, it would seem far better to allow the ship to settle steadily in the water until the main armor belt is entirely submerged, rather than to have her heel to an alarming extent; and for this reason, in these ships, I think that all unprotected water-tight compartments at the water line, forward and abaft the armor, should

extend the entire width of the ship in order to prevent the ship "heeling" when they are caused to fill through shot holes. It requires about forty tons to increase the draft one inch in these ships when at their normal displacement, and consequently it would not take a very large compartment of water to completely submerge the armor belt when on an even keel, and thus our battleship is again reduced to the level of an armored cruiser, even when she started out with very little coal in her bunkers. For these reasons I am decidedly opposed to the dangerous theory of partial armor belts, which leave both ends of a ship entirely unprotected; and, as I said before, a few shot holes at the water line of these unarmored ends would soon admit sufficient water to put the main armor so far below water as to be of no use; and a few more shot through the four-inch armor, which would now be the only water-line protection, would soon admit enough water above the armored deck to cause the ship to turn over or to put the heavy guns out of action by the angle of heel. In my opinion, it would be much better to have a lighter and wider armor belt extending from stem to stern than a partial armor belt of great thickness. In our new ships we have advanced one step by extending the armor belt to the bow, but the after-part of the ship remains unprotected by side armor; however, in our future ships we may have the pleasure of seeing a complete fore and aft belt of armor protection and more freeboard; and then we can truly say that we have built an ideal battleship—one that can fight when in cruising trim, and one that cannot be reduced to the level of an armored cruiser by the striking of a few shells at the water line of the unarmored ends.

SPARE ARTICLES.

The argument always advanced against a complete armor belt is that these ships, on their present displacement, cannot carry the weight at that height; but why not dispense with various weights that we now find on board our battleships and which have nothing to do with the *fighting qualities* of the ships? Our ships are entirely too complicated and have too many encumbrances for fighting machines. Walk through a battleship when she is cleared for action and note the hundreds of articles that are struck below on account of not being a part of the fighting outfit, and see the many things marked "overboard" on account

of belonging to the *peace equipment*. These are the articles that complicate and encumber our battleships and take the place of weight that should be given to *armor* for the unprotected ends of the ship. It is impossible to obtain the most efficient results if we design a fighting ship with the idea of fitting her with both a *peace equipment* and a *war equipment*: and I firmly believe that every battleship should be always kept in fighting trim—even to the color of the paint—and that all superfluous articles should be sent on shore.

STORES AND EQUIPMENT.

I cannot see why battleships should be supplied with everything in the way of stores and equipment that are supplied to cruisers when fitting out for a three years' foreign cruise. Our battleships are principally for home defense and their radius of cruising is limited by our coaling stations; therefore, why not limit their outfit of stores and supplies to a certain extent—say six or eight months—and thus do away with the great weight due to over-abundance of stores, which weight should be given to *more ammunition* and to *armor* for the unarmored ends. There is no reasonable argument for filling the store-rooms of our battleships with from two to three years' stores when their coal capacity limits them to twenty-four days' steaming at the outside. Each one of our battleships is burdened with enough spare articles and enough needless stores to fit out another ship of the same class in time of war. If, in war times, our battleships are to remain on our own coast on the defensive, then they are at the very base of supplies, and they can be kept filled up with coal and stores; if they are sent to the enemy's coast to act on the offensive, they must necessarily be accompanied by coal-laden steamers; so why not at the same time have them accompanied by supply ships? Every fleet of heavy ships should have its fast colliers and supply steamers, and then battleships could dispense with the present plan of carrying large quantities of stores and spare articles, the weight of which tends to sacrifice an ample ammunition supply and prevent more side armor.

TORPEDOES.

Next, let us gain weight by doing away with torpedoes in battleships, for are they not entirely out of place in battleships,

in armored cruisers, and in large vessels designed as scouts? I cannot imagine any circumstance under which a battleship would dare use her torpedoes, unless it would be to give the "knock-out blow" to an already defeated and disabled enemy before he could lower his colors; and it would seem poor judgment to approach within torpedo range of an enemy that is already whipped, because *he* might possibly have an uninjured torpedo tube and that would put both vessels upon an equal footing again, thus possibly throwing away the victory that previously had been won. Cruisers will use their high speed to avoid engagements with battleships, and therefore battleships will in most cases be opposed by battleships or armored cruisers. In such engagements the battleships would probably never be within torpedo range of each other, and if by chance they should close to 800 yards, would any commander dare open his broadside torpedo ports and attach the war-head in the face of the terrific fire of his opponent's numerous rapid-fire guns?

A better target for rapid-fire guns at 800 yards than an open torpedo port in the armored side of a battleship could hardly be desired; and if the "men behind the guns" fail to explode the air-flask or war-head, they would most certainly destroy the tube itself. The Oregon has a bow tube, a stern tube, two starboard broadside tubes, and one port broadside tube—all above water. Her bow and stern tubes are fixed, and as they are not protected by armor, they may as well be eliminated from the discussion. The broadside training tubes are behind four inches of armor, which offers little protection against the main battery of a battleship. Besides, the broadside tubes could not be opened except in smooth water; the bow tube could never be used when under way excepting at very slow speed, a speed at which the Oregon's helm is of so little use that she must be handled with her engines. It is claimed from experiment that war-heads will not explode when struck by rapid-fire shell unless the small detonator itself is struck; but would any commander of a battleship be willing to stake the fate of his ship in battle upon this assumption, merely for the sake of obtaining a chance shot at the enemy, provided his tube and air flask have not already been penetrated? I do not believe that any commander would so menace his own ship, when in action, as to open his torpedo ports and attach the war-heads as long as he could fight a single gun. If every gun

has been silenced and the enemy should be so indiscreet as to approach within short range, then a torpedo might possibly prove successful against him; but when a ship has been so seriously battered as to have every gun disabled it is hardly possible that her torpedo tubes remain uninjured behind only four inches of armor, not to mention what would occur when the torpedo ports are opened and the tubes exposed to fire. In my humble opinion, torpedoes in battleships, in armored cruisers, and in scouts, are out of place and are a menace to the ship that carries them; and I believe that in the near future our policy will be: *Torpedoes in torpedo vessels and in nothing else.* However, if we *must* have torpedo tubes in our battleships, let them be submerged. I consider that the appropriation for each battleship or armored cruiser should contain a provision for two torpedo-boat destroyers. These two "destroyers" should attend the battleship during all manœuvres, and in time of hostilities they should serve as her "faithful watchdogs" at night, being always on the alert for torpedo-boats and rams. The service that these "destroyers" could render a fleet of fighting ships would prove most valuable: some on the scout and others on the lookout. They could form an inner picket line for the fleet, the outer line being formed by the large cruising scouts. How much more secure and comfortable the fighting ships would feel, when on the blockade or when approaching the enemy's coast, if each had two effective torpedo-boat destroyers to insure protection from the ever-dreaded little "night prowling" torpedo-boats. The two "destroyers" should be a "part and parcel" of the battleship and under the orders of her commanding officer; and they should look to the "mother ship" for all supplies when cruising and also for protection from the enemy's fighting ships. During action they could possibly find shelter under the unengaged side of their powerful protector and be ever ready to dart forth to repel the onslaught of torpedo-boats. Thus, for protection against the enemy's torpedo-boats, the fleet should rely upon *its own* "destroyers," and not upon useless torpedo-nets.

BOATS.

Why should a battleship be burdened with *fourteen boats*? Why not do away with some of these weights which are carried so high? Then we could also dispense with two of the four

heavy boat cranes of the Alabama class, for every pound at that height *counts*.

From the fact that ships continue to carry large numbers of boats in cradles on the upper deck beams, it would seem that little apprehension is felt for the fierce blaze that these boats would make if set on fire by a bursting shell. In our battleships the boats are carried on the beams at the height of the bridge deck, and some are stowed in nests of three; thus they would make a superb target for rapid-fire guns and would probably be set on fire within the first ten minutes of an engagement. If shell should penetrate either smoke-pipe below the height of the boats, the heat coming through the shot holes would also assist in setting the boats on fire. Consider for one moment the serious effect of a fire among the boats during an engagement. Even should the lines of hose that are fitted on the upper deck remain intact, it would be next to impossible to subdue the flames in the face of the enemy's rapid-fire battery; and the heat would very soon drive the crews of the secondary battery from their guns and the captain from the conning tower. The fire, once started, would take all the boats and would find more fuel in the pilot house, the bridge deck and hammocks, so that it would become a rather serious matter. Such a fire would deprive the ship of her secondary battery, and, as no man could live in the conning tower when surrounded by such a blaze, it would deprive the ship of *every means on deck of manoeuvring*—a most appalling situation during an engagement. Possibly the enemy may be practically defeated, when suddenly he sees all our upper works in flames and is given encouragement to continue the fight with renewed vigor, possibly turning defeat into victory. I consider this a subject for very serious thought in connection with our battleships in commission and those building, and it seems to me that the remedy can be easily applied. In the first place we should change from wooden to *metallic boats*, except possibly the two life-boats carried at davits; and in the second place our boats should be *reduced in number*. We still cling to the ancient idea that a ship's boats must be able to carry all the crew in case of abandoning ship—an impossible proposition in a seaway if a week's water and provisions are to be carried. An attempt to use the unwieldy boat cranes for hoisting out boats in a seaway would certainly prove as unsuccessful as the innocent propo-

sition of a *landsman*, who recently visited this ship, was amusing. The landsman asked why the ship carried so many boats, and he was told that they were required to be able to carry all the men in the event of abandoning ship. He then asked how we would get the boats in the water, and he was answered that they were supposed to be hoisted out at sea by the cranes, but that the success of the undertaking would be in doubt. Our landsman thought for a moment, and then his face brightened as he conceived a *brilliant nautical idea*, and he said, "If the ship is sinking, why not leave the boats in their cradles and put the men in them, then get the oars ready, and when the ship goes down and the boats float, *pull away* like thunder!" I fear that an attempt to get the boats out at sea with our boat cranes would come near meeting with the same fate as the "hayseed" proposition of our innocent landsman. We must give up the idea of having to abandon ship at sea, for it would be impossible to hoist out the boats without smashing them to pieces; but if successfully launched and filled with the men and the provisions that they are required to carry, they could not live in even a moderate sea. We must look at this matter in a cold practical way and decide to *stand by the ship*, and survive or perish with her, for that is the plain common sense of it. Boats are of very little use at sea to a modern ship, except to rescue a man overboard. In our present age of high-powered twin-screw steamers we have eliminated the anxiety of being "knocked down" or "driven on a lee shore," which were the most frequent misfortunes that compelled the crews of the old-time sailing vessels to take to their boats and "abandon ship." Necessity for abandoning ship at sea at the present day could only be brought about by very severe weather or by a collision. In the former case—a very improbable one for a well built steam vessel—the few davit boats of a man-of-war might possibly get clear of the ship with a few men, but the large boats in the cradles could never be hoisted out during a gale that would imperil the ship, consequently the majority of the crew must stand by the ship and trust to her seaworthiness. In the case of a collision at sea between modern ships their safety would depend upon the rapidity of closing the water-tight compartments, and therefore the crew would have to trust their lives to the good condition and successful working of the water-tight doors. If a collision is so severe

that the water-tight compartments of a modern ship will not keep her afloat, then there will be no time for getting out and provisioning boats. In case a ship is stranded a few boats will do the work of rescue and of getting a line through the surf. In time of war there must be no such thing known to a man-o'-warsman as "abandoning ship"; he must make up his mind to stake his fate with his ship and either cheer her colors in victory or go down with her in defeat.

A battleship's outfit of boats should consist of two large steam cutters capable of carrying sixty men each, two large launches capable of carrying seventy-five men each, two life-boats and two dinghies; the steam cutters to be used for all running and towing purposes, and with the launches to be used for carrying stores or landing an armed force.

I am glad to see that in our new ships the lofty and useless battle-mast is reduced to a mere fighting tower, and therefore we have dispensed with one menace to the fighting qualities of the ship.

ARMAMENT.

The most important subjects in battleships are the armament, armor and ammunition supply; and all else, excepting the engineering department, must be sacrificed for these three main fighting qualities.

When the United States Government commenced building a navy the policy was to have her ships armed with *more guns* and with guns of *greater range* than were carried by the war vessels of other nations. That policy was carried out in our early wars, and history records the splendid victories, and these victories were made possible by the large number of long-range guns carried by our ships.

Up to the time of designing the battleships that are now on the stocks, our uninterrupted policy had been to build ships that excelled in battery all foreign ships of the same class, and our Oregon class maintained this policy, as their eight-inch guns far outclass the six-inch guns of foreign battleships. The Kearsarge and Kentucky are somewhat doubtful about maintaining our cherished policy, as many look upon their superimposed turrets with a skeptical eye. However, in our latest battleships we have completely abandoned the policy that we had held to for a century, as these ships are designed to be the *equals* of

foreign battleships in armament, gun for gun, and *not superior* to them. We have abandoned the splendid eight-inch guns which made our Oregon class superior in armament to any ship afloat, and now we have nothing but six-inch guns to back up the thirteen-inch. I think this is a very unwise departure from the policy that always brought us victory in our past wars; and should our Alabama class engage with ships of the same class I fear that the victory would hang in the balance, while it would be insured had our ships been given the eight-inch guns. I consider the forty calibre eight-inch gun a superb piece of ordnance, and one that we can ill afford to dispense with in our battleships, although I do not commend the eight-inch turret mounts in the Oregon class. Those turrets simply invite disaster, as they are perched high in the air, with only a four-inch armored ammunition tube underneath them for protection. These turrets make an excellent target, and one five-inch shell striking and exploding in the armored tube under the barbette would throw the turret and its two eight-inch guns out of action. Why not mount a single eight-inch gun *en barbette on the main deck* at each angle of the superstructure, the barbette being twelve inches thick and carried down to connect with the main armor belt, thus insuring absolute protection for the ammunition, and eliminating the chance of having the eight-inch turret "struck beneath the belt" and being "knocked out"? I would also mount an eight-inch gun *en barbette* on the main deck amidships. This plan would give three eight-inch guns on a broadside with splendid protection, and the weight of the armored barbettes would not exceed the weight of the present turrets. These guns should be worked entirely by hand gearing, and I believe that these three guns on a broadside could deliver more shots within a specified time than the present four guns mounted in two turrets. I would mount two six-inch R. F. guns on the broadside between the eight-inch barbettes, one in each diagonal of the superstructure, well inboard, two on the upper deck amidships, and two under the forecastle—thus having eight six-inch guns in a broadside. Of course, the six-inch guns in the diagonals would have a very limited arc of fire. I would have the upper deck fairly bristling with *twelve-pounders* and *six-pounders*.

The present plan in the British ships of enclosing each six-inch gun by a thick Harveyed steel casemate is an excellent idea.

It guards against a raking fire and at the same time it shuts off each gun from the view of its neighbor. This causes each gun's crew to be more independent and prevents its demoralization upon seeing the crew of an adjacent gun swept away by a bursting shell.

The eight-inch guns of the Oregon class cannot be fixed in a fore and aft line without endangering the officer in the hood of the thirteen-inch turret, but if they were mounted on the main deck there would be no danger from a fore and aft fire.

It appears that the tendency in the British navy, and I regret to say in our navy, is to reduce the number of guns and to increase their arcs of fire; and also to have no guns above six-inch calibre for supporting the twelve or thirteen-inch. This method of decreasing the number and calibre of guns is an ideal theory for reducing weights; *but ships are built to carry guns and to fight*, and it would seem better to reduce weights elsewhere than in the battery and ammunition. A comparatively small number of guns are thus placed on board our new battleships, and each gun commands a large arc of fire; but the theorist does not consider the fact that one shot may disable a gun, and then a large arc is without a gun to cover it. I believe in a large number of guns with reduced arcs of fire, for then you will have more guns, in proportion, at all stages of the battle; and, if necessary, the ship can be manœuvred to bring the last guns to bear. If every gun in the ship's armament is to have an extensive arc of fire then it is impossible to carry many guns, and when these few are disabled the ship is defeated. I do not see how a battleship can have *too many guns*, even if they are placed side by side; and to me it seems a sin to build a great battleship of 12,000 tons like the Alabama and give her a main battery of only four thirteen-inch and fourteen six-inch rifles. To my mind she should have a main battery of four 12-in. B. L. rifles mounted in turrets at least twenty-five feet above the water; six 8-in. B. L. rifles mounted singly in barbettes on the broadside (as described above) at least eighteen feet above the water; and sixteen 6-in. R. F. guns mounted in armored casemates on the broadside. The British Majestic class should be able to carry, on their 15,000 tons displacement, at least six 8-in. B. L. rifles and several more 6-in. R. F. guns than they have at present; but those ships have a superb secondary battery in their sixteen

12-pdr. (3-in.) Q. F. guns and twelve 3-pdr. Q. F. guns. However, I prefer a smaller number of 6-pdr. Q. F. to the 3-pdr., but the 12-pdr. Q. F. are excellent guns.

Consider what a terrific broadside fire could be maintained by a main battery of four 12-in. guns supported by the eight-inch and six-inch. I think that 12-in. guns should be the heaviest guns mounted on board ship, and I believe they will do more execution than the 13-in., on account of their greater rapidity of fire.

In the present age when heavy fighting ships cruise in fleets, naval engagements between single ships will be rare; consequently during battle each ship of a fleet will have no trouble in finding enough of the enemy's ships to serve as targets for all the guns of her battery, and there need be no fear of some guns not bearing on the enemy's vessels. Therefore I claim that the ship that mounts a large number of guns with small arcs of fire will be superior to the ship with fewer guns and large arcs of fire. The former vessel will be able to deliver many more pounds of metal against the enemy's various ships; and contests between fleets of battleships will be decided by the weight of shell thrown by guns of 6-in. calibre and above. Consequently, when we abandon the 8-in. guns in our new battleships we surrender the great advantage that we have always maintained over foreign ships, and we reduce our armament to the same plane as theirs. We should endeavor to retain the 8-in. guns in our broadside, because, like the past, the naval engagements of the future *will be fought with broadside fire* and not with a fore and aft fire.

In an engagement between battleships of similar armor and displacement, which one will probably be the victor? There can be but one answer; for it will be the one that effectively delivers the greater amount of steel against the other ship. During the engagement each ship will necessarily lose the use of numerous guns and men, and therefore the ship that carries the larger number of guns and that has a reserve force of men below in protected places for filling the vacancies at the remaining guns, will certainly have the advantage; and some obscure guns that are generally looked upon with disfavor on account of their small arcs of fire may, at the critical moment when their companions of large arcs are dismounted, become the means of insuring victory. Give us guns galore, for the time will come when each

gun will give a good account of itself, and our terrific broadsides will bring us victories as they have in the past.

COMPLEMENT.

Our battleships have not enough officers and men to fight the guns efficiently, to supply ammunition rapidly, and to form a reserve force for filling vacancies.

In naval warfare between first-class powers, the one that can fight the greatest number of guns and men throughout the action will be victorious; and therefore the first consideration should be given to supplying ships with large crews and with as many guns as can be carried. Consideration should also be given to protecting the men and the guns by armor in order to retain their services as long as possible. In battle the prime object is to kill as many men as possible, thus silencing the enemy's guns by depriving them of their crews. No matter how riddled and battered a ship may become, as long as she floats and guns remain intact the men will fight desperately, so it follows that the men must be killed, the guns dismounted, or the ship sunk in order to insure victory, and the easiest plan is to kill.

When battleships of the Oregon type engage other battleships it would be simple slaughter to keep the crews of the 6-in. and 6-pdr. guns at their exposed stations when at long range, and I believe that a wise commander would send the crews of these unprotected guns to seek shelter below behind armor, and thus have them ready to fill vacancies in the crews of the heavy turret guns and to man their own guns when at close, effective range. It will be absolutely necessary to have a *reserve force* of men in well protected places below for the purpose of filling vacancies as they occur at the guns.

If the 6-pdr. crews are kept at their guns from the beginning of an engagement, I fear that none of them will be alive to fight their guns when they become of use at short range. If the opposing battleships have their heavy guns mounted *en barbette* and not in covered turrets, or when engaging cruisers with their exposed gun crews, then it would be necessary to fight the 6-in. and 6-pdr. guns when within moderate range; but otherwise it would be folly to allow those gun crews to remain at their exposed stations as a target for the enemy's heavy guns at long range. Our heavy guns behind thick armor are the ones that

must be depended upon to do the fighting at long range, and the crews of the smaller guns must be sent below for shelter. *Preservation of the fighting men* is bound to be the all-important rule of the successful commander.

THE BATTLESHIP AT SEA.

The word *battleship* should imply that the ship is able to give battle to any vessel afloat, no matter where or when encountered. Do our present battleships fulfill this requirement during moderately bad weather at sea? Only once during her commission has the Oregon put to sea without encountering a moderate or a severe gale, accompanied by rough to heavy seas. During none of these gales could she have fought the guns of her main battery, except possibly her 8-in. guns at intervals, nor could she have fought her 13-in. guns until hours after the gale had "blown itself out." If it were possible to control and point the 13-in. guns with the ship rolling from eighteen to twenty-nine degrees, would it be wise to take off the port bucklers and run out the guns when the main deck and turrets are being swept by seas at every roll? Under such conditions it would take a very few minutes to flood the turret chamber and also the shell-rooms and magazines surrounding it. When a vessel of the Oregon type is in a moderate gale, rolling from fifteen to twenty-five degrees, with her main deck awash, an armored cruiser of the Brooklyn class could come along and "knock seven bells" out of her. The battleship could not run away, she could not use her heavy guns, and thus she would be at the mercy of the large cruiser, which having greater freeboard and more steadiness could use her guns in all kinds of weather, and with her higher speed she could manœuvre to select her range and her time for placing shell beneath the battleship's armor belt as it comes out of water with each roll.

For the reason that our low freeboard battleships cannot fight their heavy guns when at sea in bad weather, I believe that a fleet of ships of the Oregon type, in time of war, should be accompanied by several armored cruisers like the Brooklyn; or a battleship cruising singly, by one armored cruiser; this for *defensive purposes during severe weather*. Therefore, to accompany our present battleships we should have more armored cruisers, cruisers that can fight under all conditions of weather; and the

freeboard of our future battleships should be such as to enable them to keep the sea and fight their guns during the freshest gales. In smooth water our battleships are superior to any ships afloat, both in battery and in manœuvring qualities; but in severe weather at sea, the new high freeboard 14,900 ton battleships of the British navy will outclass them. Our battleships of the Oregon class were originally designated "coast-line battleships," but the wind and seas along our coast are about as severe as anywhere else, and therefore such ships should be able to use their guns under all conditions of weather.

The sea-going qualities of the Oregon have been thoroughly tested in numerous gales, and I have such *absolute confidence* in her *seaworthiness* that I believe she can easily weather any gale that blows, even now before she has had her bilge keels fitted. Last April, when off Cape Mendocino, the Oregon was "hove to" for about thirty hours during one of the most severe gales that had been experienced on this storm-swept coast for a long time, and she behaved *beautifully*; but, of course, her main deck and 13-in. turrets were under water continually. Although she is excellent as a "sea-boat," still there is no denying the fact that this type of ship cannot fight the heavy guns during gales when the turrets are being swept by seas and when rolling from fifteen to twenty-nine degrees. Take the Oregon on the smooth waters of Puget Sound, and let her have very little coal in her bunkers in order that the armor belt may be at the proper height above water, and she will make a very ugly fight, but after an hour's hot fighting at moderate range I would have grave fears for her safety, on account of her *unarmored ends*. However, when a ship requires the *conditions of smooth water and little coal* in her bunkers in order to make a good fight, *she practically abandons her position as a battleship and becomes a harbor defense vessel*.

It is very seldom that a ship can cruise along the Pacific coast of the United States without meeting bad weather, and the only harbors along the 1200 miles of coast that battleships can enter are San Francisco and Puget Sound ports.

Puget Sound with its smooth, deep waters is the ideal place for our low freeboard battleships, and here they would do superb fighting; and if they only had the fore and aft armor belt, and if the 8-in. turrets were on the main deck with protection under-

neath, they would really be *perfection* as defenders for such waters as Puget Sound.

I have intense admiration for the Oregon class of ships, but, unlike some officers, I do not believe them to be the best fighting ships afloat, for I consider that a battleship should be able to fight at sea in any weather short of a hurricane; that is, in any weather during which a cruiser could use her guns. To my mind, the extension of the armor belt forward and the higher freeboard of our Alabama class is a decided step in advance over our present battleships; but 'tis a pity that a backward step should be taken in the omission of the 8-in. guns from the battery, and in not extending the armor belt all the way aft.

One must, necessarily, admire the new British battleships of 14,900 tons, in which, on 3000 tons more displacement than our ships, they have a *high freeboard, sea-fighting battleship* with a "*very large area of side protection*," and with a *hull of sufficient strength to prevent all fear of docking*. It seems too bad that the Majestic class have not a narrow armor belt continuing to the bow and stern, for then their fore and aft belt and their side protection would make them very undesirable as an enemy.

CONCLUSION.

Let us hope that our battleships of the future will have complete armor protection, that they will have a few feet more freeboard, that the armor belt will be in the right place when in war-time cruising trim, that they will not be burdened with so many boats and other peace-time encumbrances, that the 12-in. or 13-in. guns will be mounted higher and be supported by 8-in. guns *en barbette*, that the rapid-fire battery will be increased, and that reserve forces of men and officers will be assigned to each ship, for then we shall possess ships which we can truly call battleships, as they will be able to stand up and give battle to anything that sails the seas, under all conditions of wind and wave.

In time of war the officers of the ship, and not her designer or builder, are the ones to be held strictly accountable for the fighting condition of the ship and for the result of battle, and it will be too late then to attempt to excuse defeat by attributing it to errors in the design, in the armament, in the ammunition supply, or in the practical equipment of the ship. Therefore I believe

that healthy criticisms and practical suggestions by the sea-going officers who man our battleships and fight the guns should be very acceptable to those in authority who create our naval policy; and also to those who are intrusted with the noble work of designing and constructing our great national defenders and who have not the opportunity of observing the practical behavior of these ships at sea. With this belief, I have closely observed the behavior of the Oregon under all conditions of sea and weather, and also the practical working of her armament and mechanical appliances; and I have noted them down from time to time in the way they have impressed me from a seaman's practical standpoint, *i. e.* as seen by "the man behind the gun," and if any of my practical suggestions serve to increase the fighting efficiency of one of our ships I shall feel very much gratified.

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DISCUSSION.

DISCUSSION OF "OUR NAVAL POWER."

Commander C. H. STOCKTON, U. S. N.—It is not my purpose to review the paper of Lieut.-Commander Wainwright as a whole. So much of it is or ought to be accepted as sound that in the main a review would be simply a re-echo of his views. There are a few points, however, which may be well to discuss, in order to elaborate or to present varying rather than antagonistic opinions. It is perhaps natural, but none the less to be regretted, that there should be such diverging views held by officers of the Army and Navy as to their respective rôles in harbor and coast defense, and also in combined operations. The lack of a common defense board or proper general staff in both services aggravates this discordance. Many military officers of high rank in both services seem even at this late day to fail to comprehend the necessity and utility of such an organization, the lack of such comprehension being, to my observation, greater in the Army than in the Navy.

The differentiating of the defense of harbor and of coasts, urged by the writer for years past, as expressed by the essayist, shows plainly the difference between the functions of the Army and Navy upon our sea frontier, and the larger and more comprehensive scope of naval coast defense over that of harbor exclusion and defense. So to my mind the alternative predominance of the Army and Navy is generally lost sight of in the question of combined operations in the attack or defense of a fortified seaport.

The attack or siege is based upon the sea, and to it the command of the sea in those regions is necessary. This free use of the sea gives the life and movement to the attack, the sea is the highway for its communications, its supplies and its reinforcements. In the attack, then, the naval force and command is essential for advance and retreat, and the naval commander-in-chief should have the pre-eminence and command of the combined forces. There should be *unity* rather than *concert* of action.

In the defensive operations the contrary exists. Everything depends and is based upon the land, whether the fort is insular or continental; the command of the sea, without which the attack is impossible, limits to the land territory the source of all supplies and resources. If the mobile forces assisting the fortifications of the fort are sea-going they are by force of circumstances and inferiority localized as auxiliary for defensive purposes; if the auxiliary craft be non-seagoing, such as those likely to be manned by naval volunteers or militia, they are still more secondary in place, and the land forces become the principals and the commander of these land forces naturally the commander-in-chief.

I do not understand the author of the paper to take the ground that the Hawaiian islands are necessary or important to us in the matter of

the defense of our Pacific coast. A group of islands at a distance of more than 2000 miles is neither of assistance for the defense of our home coasts nor of use to an enemy for purposes of attack upon such coast. Its importance, strategical and otherwise, to my mind, is due to its position as a stepping-stone to what is beyond and as a coaling station, with docking facilities, at a crossing of sea highways.

It does not require a separate fleet to defend, as the sea-going fleet that defends our Pacific coast from Attu to San Diego likewise defends the Hawaiian group against the only objective—the enemy's fleet. The distances from the home ports of origin of possible enemies causes a filtering and reduction of available force for offensive purposes to a size which we should be able to readily meet.

Attention has been called, and not improperly, to the fact that the great circle routes between North American ports and the extreme Orient go long distances to the northward of the Hawaiian group. This will be doubtless a factor, as the Alaskan coast and the Aleutian group furnish sufficient ports of trade to attract the cargo or tramp steamer along our own coasts and islands; but such is not the fact now, and few, if any, of the steamers in crossing the Pacific follow the extreme great circle routes.

It is not unfair to suggest the analogy between weather and sea conditions and the topography that dictates routes for armies and railways—the fog, high winds and rough seas of the northern Pacific in practice are related to the rough topographical features of uninhabited regions, and force most of the sea routes, even for steamers, to the southward of the great circle routes to Japan. Neither the Canadian Pacific steamers from Vancouver nor the Pacific mail steamers from San Francisco ever take the extreme great circle route, while the number of steamers that take the longer routes and call at the Hawaiian group is increasing every year.

PROFESSIONAL NOTES.

A NEW SECTIONAL GUN.

The sectional gun which is illustrated in the accompanying cuts has been designed to avoid the use of the great pieces of steel used in the construction of large modern guns of the ordinary type, and to avoid the uncertainty as to the strains in such large pieces, especially with hoops heated and shrunk on. It is also claimed that by this sectional construction the life of guns will be greatly increased, since the inner tube can be



FIG. 1.

removed and renewed, and the body of the gun is not liable to deterioration, for the seams between the rings prevent the setting up of continuous and destructive vibrations. The transportation and erection of guns would also be greatly facilitated. The general appearance of the gun is shown in Fig. 1.

The gun consists of a series of rolled steel rings, or rather bored disks, the boring being done to a taper to fit the taper of the inner rifled steel

tube. These disks are fitted in position by means of dowel pins, and are held together by four longitudinal rods with threaded ends passing through lugs on the end pieces of the gun, while the disks of the breech

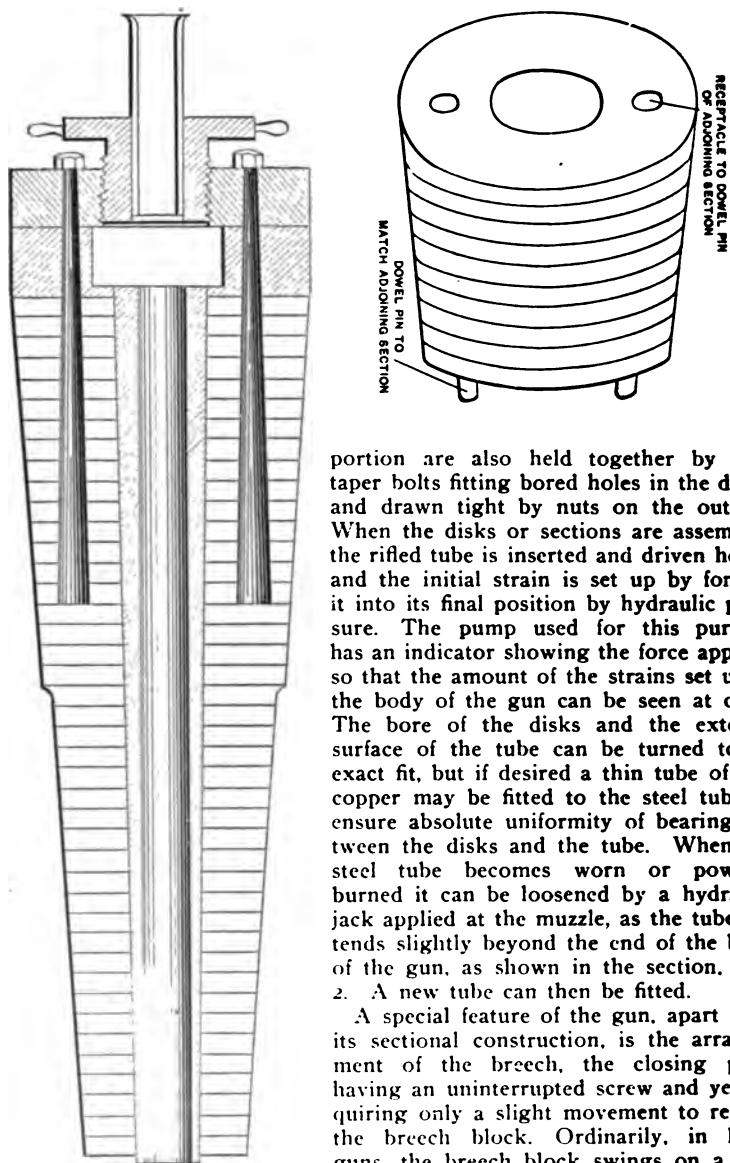


FIG. 2.

portion are also held together by four taper bolts fitting bored holes in the disks, and drawn tight by nuts on the outside. When the disks or sections are assembled the rifled tube is inserted and driven home, and the initial strain is set up by forcing it into its final position by hydraulic pressure. The pump used for this purpose has an indicator showing the force applied, so that the amount of the strains set up in the body of the gun can be seen at once. The bore of the disks and the exterior surface of the tube can be turned to an exact fit, but if desired a thin tube of soft copper may be fitted to the steel tube to ensure absolute uniformity of bearing between the disks and the tube. When the steel tube becomes worn or powder-burned it can be loosened by a hydraulic jack applied at the muzzle, as the tube extends slightly beyond the end of the body of the gun, as shown in the section, Fig. 2. A new tube can then be fitted.

A special feature of the gun, apart from its sectional construction, is the arrangement of the breech, the closing piece having an uninterrupted screw and yet requiring only a slight movement to release the breech block. Ordinarily, in large guns, the breech block swings on a vertical hinge and has an interrupted screw

thread (cut away longitudinally) so that it will not require a large number of turns to send it home. In this gun the breech block slides laterally in a chamber across the breech and the breech screw merely forces it tight against its seat. When the gun has been fired the screw is turned back slightly, releasing the block, which is then pulled out at the side of the gun. The steel tube or sleeve in the breech, which is shown withdrawn in Fig. 2, is then pushed in, as at Fig. 1, and the cartridge is passed through it into the chamber at the rear of the bore, the rim of the flat end of the cartridge projecting slightly outside the rifled tube. The sleeve is then withdrawn and the breech block slid back, a circular recess in its face fitting the flat end of the cartridge. The steel screw is then turned, pressing the breech block tightly against the end of the cartridge and the rifled tube, and thus forming a gas-tight joint. A bolt in the head of the gun engages with a groove in the back of the breech block, and forms a gauge to ensure its being in proper position. The gun is then fired by the lock shown in the end of the breech block, the screw reversed, the breech block slid out, the sleeve pushed in and the cartridge removed.

The gun is the invention of Mr. Edwin J. Blood, of Chicago, and is being handled by the American Sectional Cannon Co., New York Life Building, Chicago, of which Mr. Duane Doty is consulting engineer. The right to manufacture the gun in Europe has, it is stated, been secured by an English company, which sent out military experts to examine the model gun built under the direction of the inventor.

It seems to us that the chief defect in this gun would be its lack of longitudinal stiffness. In the early experiments with wire-wound guns trouble was experienced with the droop of the muzzle until an external jacket was adopted, and we should suppose something of the same sort would be necessary here, unless for very short pieces, such as mortars.—*Iron Age.*

THE DIAMOND SHOAL LIGHTSHIP No. 69.

The lightship here described has now been in position off Cape Hatteras for the last three months and has successfully withstood the heavy gales of the present winter at that dangerous point. The ship is anchored in 30 fathoms of water, and her general performance has been satisfactory to the Light House Board, as tending to show that a lightship can be safely maintained there and serve as a much-needed beacon and warning for mariners.

Both lightships, Nos. 68 and 69, were built at the Bath Iron Works, of Bath, Me., and No. 68 is now stationed off Fire Island, at the entrance to New York harbor. The same dimensions apply to both. They are strongly built, composite vessels, 122 feet 10 inches long over all, 29 feet 6 inches beam and 22 feet molded depth. The two steel masts supporting the electric lights are 64½ feet high, and each carries a gallery for day signals. The propelling machinery, to be used in steaming to the station or away from danger, is operated by simple, condensing, vertical engines, with 20-inch cylinders, 22-inch stroke and 350 H. P., at 150 revolutions. Steam is supplied, at 100 lbs. pressure, by a steel Scotch boiler, 12 feet 2 inches diameter and 11 feet long. Two vertical donkey boilers furnish steam for the electric lighting plant, windlass, pumps, fog signals and heating. Each vessel is fitted with steam-steering gear, bells, steam winch, anchors, chain cables, etc.

The electric plant, which is in duplicate, was made by the General Electric Co., of Schenectady, N. Y. Each plant contains two marine generating sets, with dynamo and engine. The four-pole dynamos are 8 kilowatt, 350-revolution machines, directly coupled to $4\frac{1}{2}$ x 4-inch double cylinder engines. These dynamos furnish a 100-volt current to eight 100-c. p. lamps, four at each masthead, and forty 16-c. p. lamps about the vessel. The masthead lights are each enclosed in a lens lantern, of which three are used and one held in reserve. Appliances are employed for breaking the circuit at regular intervals, so that a fixed white light shows for 12 seconds, followed by an eclipse of 3 seconds. The focal plane is 57 feet above the sea and the lights will be visible for 15 nautical miles in clear weather.—*Scientific American*.

GUN OF NEW TYPE SUCCESSFULLY TESTED.

A very interesting and highly satisfactory preliminary test of a new type of steel gun was conducted during the latter part of January at the Sandy Hook Proving Ground. The gun, which is of the 5-inch rapid-fire class, is so simple in construction that no drawings are needed to describe it to our readers. It is made of a single forging of steel, which, having followed the course of manufacture usual for large gun forgings, was, at a proper stage of manufacture, cooled from the interior from such temperature as to produce properly disposed initial strains of such intensity as would place the wall of the gun in the best condition to resist interior pressure.

The manufacture of the gun is due to the suggestions of Capt. F. E. Hobbs, Ordnance Department, United States Army, who pointed out several years ago to the chief of ordnance the advantages that could be obtained in the manufacture of guns by applying to forgings a modification of the Rodman principle of casting guns; that the process as applied to forgings could be made to produce exactly the initial strains desired; that these strains could be easily increased or diminished at little cost, and that guns so made, while quite as strong, would be much cheaper to make than those built up.

An experimental forging made under Capt. Hobbs' direction at the Bethlehem Iron Works showed such excellent results, on being cut up and carefully examined, that the chief of ordnance ordered this 5-inch gun to be manufactured.

The thickness of metal which the gun should have and the proper initial strains to be applied to give great strength were computed by Capt. R. Birnie, ordnance department, from his formulæ on the strength of guns. Capt. Birnie was an early convert to the methods of manufacture proposed, and has materially assisted Capt. Hobbs in perfecting the details of plans.

The gun is fitted with Gordon's breech mechanism, uses fixed ammunition, smokeless powder, a projectile weighing 55 pounds, can be fired from six to ten times per minute, depending upon the conditions of loading and aiming, and has a range of more than six miles. In the Sandy Hook tests a velocity of over 2700 feet per second at the muzzle was shown, and in the special high pressure test to which the gun was subjected, pressures were registered of nearly 50,000 pounds per square inch.

The method of manufacture can be applied to forgings of any size that

can be turned out by the steel-producing plants of the country; consequently the calibre of gun which can be made of a single forging may be, to-day, set at 8-inch, but, by using this method, the number of parts in guns of larger calibre could be much reduced, while the guns themselves would be stronger.

It is probable, also, that the commercial engineering interests of the country will be found ere long following the lead of the ordnance department in this latest improvement in the treatment of steel forgings, as they did many years ago, in demanding for their structures oil-tempered and annealed steel forgings, after that department of the army had shown conclusively, by careful experimental investigation and by actual test, the safety and superiority of such metal.—*Scientific American*.

SCHNEIDER-CANET QUICK-FIRING AMMUNITION.

The chief characteristics and new features of the Schneider-Canet ammunition are as follows:

(1) The complete separation of projectiles from cartridges up to the moment of firing.

(2) The employment of one special shell for several purposes. The system is applicable to all calibres alike, but offers the greatest advantages for field service. The temporary attachment of the projectile to the cartridge is carried out by means of a sort of bayonet joint fitting, by which studs in the interior of the metal cartridge mouth enter grooves of the bayonet joint form on the projectile base, which is readily done by a push and twist when desired.

This shell combines a maximum amount of mitraille with great structural strength. The central space is filled with a compact composition generating a great quantity of smoke and of high incendiary power. This gives the advantages of a burst which is strikingly visible and of the power to set fire to combustible material.

In short, it is claimed for the system thus briefly described that it combines the following advantages belonging respectively to ammunition with charge and projectiles fixed together and kept separate from each other. Under the head of the former are chiefly the rapid loading in a single operation without the use of a rammer, regular and accurate placing of the projectile in its true position in the bore. Under the head of advantages of separation are the better packing and handling of charge and projectile separately, the prevention of accidents to the rim of the brass case in transport, the power of testing, examining, and re-charging the cartridges at any time, and the reduction of the length of the metal at the neck of the case. In addition to the above the following advantages are obtained: The employment in the field of a single projectile which involves only a single scale of elevation and fuse; the regulation of fire and visibility of burst at all ranges; a great effect on troops in consequence of the great delivery of mitraille; an effective attack on existing defensive works and on the defenders behind them; the ignition of buildings and wooden structures; and the doing away with cast-iron shells, case shot and incendiary projectiles as distinct classes by the substitution of one projectile.—*Engineer*.

PRESERVATION OF BOILERS.

A method of preserving boilers not in use has been prescribed for the French navy. According to this the boilers are completely filled with fresh water, and in the case of large boilers with large tubes there is added to the water a certain amount of milk of lime or a solution of soda; in the case of tubular boilers with small tubes milk of lime or soda is added, the solution, however, not being so strong as for the larger tubes, in order to avoid any danger of contracting the effective area by deposit from the solution. The strength of the solution is to be just sufficient to neutralize any acidity of the water. Care is enjoined to be taken to preserve the outside of the steel or iron tubes in those boilers which are not to be used for long periods; such are for this purpose painted with red lead or coal tar as far as it is possible to reach, while for those portions which are inaccessible a protective coating is obtained by burning under the tubes a certain amount of tar or coal tar, the smoke of these forming a coating of soot, which prevents the air from reaching the surface of the tubes. Besides this treatment the boiler casing is closed and kept air-tight, after some quicklime has been placed inside. Periodical inspections of these boilers are made to ensure the complete filling of the tubes.—*Engineer*.

TESTS OF CORN PITH CELLULOSE.

Some experiments were carried out by the Gunnery Establishment at Portsmouth on January 18th with the view of testing the powers of corn pith cellulose in stopping leaks. This material has been introduced from America and is said to possess great advantages over cork when used for packing cofferdams at the water-line in the unarmored ends of ships of war. A cofferdam had been erected in the Nettle 3 feet thick and it was tightly packed with cellulose blocks. In front and at the rear of the cofferdam were steel plates, so as to represent the side of a ship. From a 5-inch gun a 50-pound shell was fired into the structure. The shell burst inside the cofferdam, blowing out a part of the rear plate and some of the cellulose. After this the water test was applied, water being made to flow into the shot-hole in front. In about 20 minutes it had soaked through the packing and was pouring out through the rent in the back plate. So far as shell fire was concerned, therefore, the result of the trial was not altogether favorable to the new invention.—*Engineer*.

TRIAL OF VICKERS PLATE.

An armor-plate experiment was conducted at Shoeburyness on December 13, 1897, the object of which was to ascertain the effect of firing a 9.2 steel common shell against a 6-inch plate inclined to an angle of 30 degrees to the normal. The plate was supplied by Messrs. Vickers and the dimensions were 6 inches by 8 feet by 6 feet. It was made of specially treated nickel steel, and was held in wood struts front and rear, which were secured at the top by screwed bolts and held at the bottom between iron slabs running parallel to the plate and buried 6 feet into the ground.

The backing was of 4-inch teak, behind which were $\frac{1}{2}$ -inch steel plates, the whole being secured to the armor plate by eight bolts. The target, as thus described, exactly represented the side of a battle-ship of the Canopus and Vengeance class. The gun used was a 9.2-inch breech-loader, giving a striking velocity of 1892 foot-seconds and a striking energy of 9460 foot-tons. The projectile was of the usual service design, weighing $381\frac{1}{4}$ pounds, and was filled and fused in the ordinary manner. The shot struck 2 feet 9 inches from the bottom and 3 feet 5 inches from the right edge of the plate, and broke up against the hardened face without materially damaging the plate in any way, beyond causing a slight indentation at the point of impact and slightly scaling it around the centre. The supports, etc., were shifted rearwards, but the plate was for all practical purposes uninjured.—*Engineer*.

TRIAL OF VICKERS GUN.

Further trials were made December 13, 1897, at Shoeburyness with the Vickers 6-inch quick-firing gun, which gave such excellent results last October. The new trials were made to test the present accuracy of the weapon after having fired 200 rounds, and also to further test its rapidity. The charge consisted of a 100-pound shell, with cordite and service primers. In the first 10 rounds, in which the gun was tested for accuracy, two of the shells actually passed through the same hole in the target. In the rapidity tests 36 rounds were fired in 4 minutes 47 seconds, in which time was included that necessary for taking the temperature of the vent head. The greatest speed attained was one round in $6\frac{1}{2}$ seconds, whilst eight rounds were fired in 7 seconds each. The gun has given a muzzle velocity of 2784 feet with a pressure of 15.9 tons. A peculiarity about this quick-firing gun consists in the fact that no metal cartridge case is used.—*Engineer*.

SHIPS OF WAR.

GENERAL.

The war-ships, exclusive of torpedo-boats, launched during the year 1897 for the various navies, with their tonnage, I. H. P., and estimated speed, were as follows:

GREAT BRITAIN.—First-class battle-ship: Canopus, 12,950 tons, 13,500 I. H. P., and 18 knots speed. First-class cruisers: Andromeda, Europa, Niobe, all of 11,000 tons, 16,500 I. H. P., and 20.5 knots speed. Second-class cruiser: Vindictive, 5800 tons, 10,000 I. H. P., and 19.5 knots speed. Third-class cruisers: Pactolus, Perseus, Pomone, Pegasus, Pyramus, all of 2200 tons, 7000 I. H. P., and 20 knots speed. River gunboats: Heron, Jackdaw, Nightingale, Sandpiper, 82 tons and 9 knots speed. Torpedo-boat destroyers: Ariel, Cheerful, Fairy, Fawn, Flirt, Flying Fish, Gypsy, Leopard, Osprey, Panther, Seal, Sylvia, Wolf, all of 300 tons, 6000 I. H. P., and 30 knots speed.

ARGENTINE REPUBLIC.—Training-ship: Presidente Sarmiento, 2352 tons, 2000 I. H. P., and 13 knots speed.

AUSTRIA-HUNGARY.—Torpedo cruiser: Zenta, 2300 tons, 5000 I. H. P., and 20 knots speed.

BRAZIL.—Double-turret monitor: Vinte e Quatro de Maio, 5000 tons.

6000 I. H. P., and 15 knots speed (originally launched in 1885), has now been rebuilt.

CHILI.—First-class armored cruiser: General O'Higgins, 8500 tons, 16,000 I. H. P., and 21 knots speed.

CHINA.—First-class cruiser: Hai-Tien, 4300 tons, 17,000 I. H. P., and 24 knots speed. Second-class cruiser: Hai-Yong, 2950 tons, 8000 I. H. P., and 19 knots speed. Torpedo cruiser: Feiting, 1000 tons, 2400 I. H. P., and 24 knots speed.

FRANCE.—First-class cruiser: Guichen, 8277 tons, 23,670 I. H. P., and 23 knots speed. Third-class cruisers: Lavoisier, 2317 tons, 6400 I. H. P., and 20 knots speed; D'Estrees, 2452 tons, 8500 I. H. P., and 20 knots speed. Torpedo-avisos: Dunois, 896 tons, 6800 I. H. P., and 23 knots speed. Despatch-boat: Kerseint, 1243 tons, 2200 I. H. P., and 15 knots speed.

GERMANY.—First-class battle-ship: Kaiser Wilhelm II., 11,180 tons, 13,000 I. H. P., and 18 knots speed. First-class armored cruiser: Fürst Bismarck, 10,650 tons, 19,000 I. H. P., and 19 knots speed. Second-class cruisers: Freya, Hertha, Victoria Louise, all of 5700 tons, 10,000 I. H. P., and 18 knots speed.

ITALY.—First-class battle-ships: Ammiraglio di Saint Bon, Emanuele Filiberto, both of 9800 tons, 13,500 I. H. P., and 18 knots speed. First-class armored cruisers: Giuseppe Garibaldi, Varese, both of 6840 tons and 13,000 I. H. P., and 20 knots speed.

JAPAN.—Second-class cruiser: Takasago, 4150 tons, 15,500 I. H. P., and 22 knots speed.

THE NETHERLANDS.—Second-class cruiser: Zeeland, 3900 tons, 9250 I. H. P., and 20 knots speed.

NORWAY.—Third-class battle-ships: Harald Haarfagre, Tordenskjold, both of 3400 tons, 4800 I. H. P., and 16 knots speed.

RUSSIA.—No large ships, but seven torpedo-boat destroyers of the Sokol type, viz. 240 tons, 4500 I. H. P., and 29.5 knots speed.

SPAIN.—First-class armored cruiser: Cardinal Cisneros, 7000 tons, 15,000 I. H. P., and 20 knots speed. Third-class cruisers: Marques de la Victoria, Don Alvaro de Bazan, both of 823 tons, 4600 I. H. P., and 19 knots speed. Torpedo-boat destroyers: Audaz, Osado, Pluton, all of 400 tons, 6000 I. H. P., and 30 knots speed.

UNITED STATES.—First-class gunboats: Wheeling, Marietta, Princeton, all of 1000 tons, 800 I. H. P., and 13 knots speed.—*Journal of the Royal United Service Institution.*

[AUSTRIA.]

BUDA-PEST.

The Imperial Austro-Hungarian coast-defense ironclad Buda-Pest has recently completed a successful series of official steam trials at Pola. The Austrian Navy now possesses three coast-defense ironclads, namely, Wien, Monarch, and Buda-Pest. These vessels have been constructed from the designs of Herr Obingenieur Siegfried Popper, of the Austrian Navy, and are in every respect similar excepting the boiler installation. The Wien and Monarch are fitted with cylindrical boilers and the Buda-Pest with Belleville water-tube boilers. All three vessels were tried at Pola, each loaded to the same displacement and run over the same course, the trials being under the observation of the same Austrian naval officers forming the commission representing the government. The principal dimensions of the vessels are as follows: Length, 305 feet; breadth, 55

feet 9 inches; draught, 21 feet; displacement, 5550 tons; armor belt, 10.6 inches; barbette, 10.6 inches; protective deck, 2.36 inches. The armament consists of four Krupp 9.4-inch; six quick-firing 5.9-inch; 15 quick-firing 3-pounder; two machine guns, two torpedo tubes. The machinery consists of two sets of triple-expansion engines having cylinders: high pressure, 33½-inch; intermediate pressure, 51-inch; low pressure, 78¾-inch; stroke, 35½-inch; steam being supplied, in the case of the Wien and Monarch, by cylindrical return-tube boilers, having a total heating surface of 15,750 square feet, and grate area of 568 square feet, and in the Buda-Pest by Belleville water-tube boilers, having a total heating surface of 22,500 square feet, and grate area of 720 square feet. The propellers of the three vessels were of the same diameter and surface; pitch being 15 feet 6 inches in the case of the Wien and Buda-Pest, altered to 15 feet 3 inches in the case of the Monarch. Appended we give comparative results of the natural and forced-draught trials of the three vessels.

Natural-draught trial of six hours' duration.

	Wien.	Monarch.	Buda-Pest.
Mean number of revolutions.....	121.7	119.8	124
Mean indicated horse-power.....	6376	6110	6608
Mean steam pressure in boilers, pounds per square inch.....	138	130	230
Ditto, at engines.....	132	121	129
Vacuum	26.4	27	27.9
Mean air pressure .....	.63	.6	nil
Mean speed of ship.....	16.7	16.2	17.1

Full-power forced draught trial, four hours' duration, during two hours of which the vessel steamed over measured course, 17 knots, accurate observations being taken as to power, speed, etc.

	Wien.	Monarch.	Buda-Pest.
Mean revolutions	131.2	135.76	135.6
Mean indicated horse-power....	8480	8900	9185
Mean steam pressure in boilers, pounds per square inch	149	145	199
Ditto, at engines	142	131	149
Vacuum	25.5	25.5	26.4
Mean speed in knots.....	17.49	17.35	17.87
Number of ventilating fans (stokehold)	8	8	4
Mean air pressure	1¾	1¾	1½

The stokers were drawn entirely from the Austrian Navy. The coal used was Nixon's Navigation, and being measured in the case of the natural-draught trial of the Buda-Pest, the consumption was ascertained to be about 1.8 lb. per indicated horse-power. Thermometers were placed in various parts of the engine and boiler-rooms, between decks, and in the cabins. The temperature registered during the trial being carefully noted, it was found that the temperature in all parts of the ship was much lower in the case of the Buda-Pest than her sister vessels. The representatives of the Austrian government considered the results of the trials as highly satisfactory, both engines and boilers working smoothly throughout. It will be observed that the adoption of Belleville

water-tube boilers enabled such a large increase of heating and grate surface when fitted in the same space as the cylindrical boilers, that a higher power and speed could be realized under practically natural-draught conditions than could be obtained with the cylindrical boiler under forced draught with considerable air pressure. It has been decided to fit Belleville boilers in the new armored vessels which are building for the Imperial Austrian Navy.—*Engineering*.

[CHINA.]

HAI-TSCHEN.

The Hai-Tschen, another of the three cruisers building at the Vulcan Works at Stettin, was launched December 11. She is of the same type as the Hai-Yung, of 2950 tons, 8000 H. P., and 19½ knots, the principal characteristics of which were given in No. 84, page 756.

HAI-CHI.

On January 24 was launched from the Armstrong Works the Hai-Chi, protected cruiser of 4300 tons, 17,000 H. P., calculated to make a speed of 24 knots, a sister ship to the Hai-Tin launched November 25.

The principal dimensions of the vessel are as follow: Length, 396 feet; breadth, 46 feet 8 inches; mean draught, 16 feet 9 inches; displacement, in tons, 4300. Her armament will consist of two 8-inch Elswick quick-firing guns, ten 4.7-inch Elswick quick-firing guns, twelve 3-pounder Elswick quick-firing guns, four 37-millimetre Maxims, six rifle calibre Maxims, and five 18-inch torpedo tubes. The vessel will have a strong steel protective deck, extending right forward and aft, so as to protect completely the machinery, magazines and steering gear, the deck varying in thickness from 1½ inches on the flat to 5 inches on the slopes. The conning tower will be built of armor 6 inches thick, so as to afford efficient protection to the steering wheels, etc., when the vessel is going into action. The total coal capacity is about 1000 tons, giving a steaming radius of 12,000 miles. The speed guaranteed on trial is 24 knots during a trial of four hours' duration.

[DENMARK.]

NAVAL BUDGET.

The estimates for naval appropriations, 1898 to 1899, amount to 6,936,922 kronen, or about \$1,845,000. Of this amount about \$300,000 to be used in the construction of a battle-ship of 5000 tons, the Herluf Trolle. The remainder to be expended in repairs of the Iver Hvitfeldt, Geiser, Heimdal and Lindormen.

[ENGLAND.]

ARGONAUT.

The Argonaut was successfully launched, January 24th, from the yard of the Fairfield Shipbuilding Company. She is a protected cruiser of the Diadem type, eight of which are already built or under construction, although the four most recently designed—consisting of the Argonaut; the Spartiate, which has been laid down at Pembroke; the Amphitrite, at

Barrow; and the *Ariadne*, at Clydebank—differ somewhat from the first quartette in indicated horse-power and in the nature of the armament mounted.

The dimensions of the vessel are as follows: Length over all, from ram end to taffrail, 462 feet 6 inches; length between perpendiculars, 435 feet; beam, 69 feet; displacement, at normal draught, with 1000 tons of coal on board, 11,000 tons. The hull is generally of Siemens-Martin steel, and the construction of the ordinary character, with frames 4 feet apart along the space occupied by the double bottom, and 3 feet apart forward and aft of this. There is a double bottom extending the full length of the machinery and boiler-room spaces, and, fore and aft of these limits, the flats of the steel water-tight magazine and of the platform decks, into which the longitudinals are worked right up to the ends of the ship, practically continue the double bottom from stem to stern. The coal capacity, at normal draught, is 1000 tons; but nearly 2000 tons can be carried, should the necessity arise for doing so, by employing the middle-deck bunkers. The hull is subdivided into a very large number of water-tight compartments by longitudinal and transverse water-tight bulkheads. Openings have been cut in these bulkheads only where it is absolutely necessary; and in such cases water-tight doors of approved pattern are fitted, all arranged to work both at the doors and by gearing leading to deck plates on the main deck. Where it is necessary for bulkheads to be cut through for ventilating trunks, or such like passages, automatic doors, closed by a self-acting counterweight, are fixed, so that if a compartment associated with the opening is flooded a small tank fills with water, raises the ballcock, and the weight, being released, falls, closing the automatic door. The stem, stern-post, and shaft brackets are of phosphor bronze, as is usual in sheathed vessels. The stem is of the ordinary ram form, and is strongly supported by the framework of the vessel by means of breast hooks and other devices, as well as by the forward parts of the armored and platform decks being built into it. The hull, below and up to about 6 feet above the load water-line, is sheathed with teak planking and coppered. Bilge keels are also fitted for a distance of 210 feet amidships; they are 3 feet in depth and splayed off at the ends, *not* disappearing at the midship section, as in the United States ships of the Wisconsin type. The protective deck, of a curved form in section, ranges in thickness from 2½ inches on the flat to 4 inches on the slopes, and covers the whole of the machinery, boilers and magazines. The conning tower forward is of Harveyized steel, fitted with the customary gear for controlling and directing the ship in action. The connections from the steering standards, etc., in the conning tower are protected by an armored trunk of thick steel leading down to the protective deck. There are navigating bridges fore and aft which secure a view over all operations on deck. The height of the forward bridge may be imagined when we say that the upper part of the stem is about 32 feet above the water-line, there being between 7 feet and 8 feet more freeboard in this direction than that possessed by the vessels of the Majestic type.

The armament of the *Argonaut* will be of the most recent character. Four 8-inch quick-firing guns in shields will replace the same number of 6-inch quick-firers as mounted on the *Diadem*. Two of these will be on the forecastle and two on the upper deck aft. Four 6-inch quick-firers will be mounted in armored casemates of Harveyized steel on the main and upper decks, capable of being trained axially forward, and four more

mounted in a similar manner capable of being trained axially aft; on either broadside are four other 6-inch quick-firers on the main deck. Twelve 12-pounder quick-firers are mounted on the main and upper decks, and two more on the superstructure forward. There are also light quick-firing and machine guns, and two torpedo tubes below water forward. The magazine and shell rooms for storing ammunition are of large capacity and are conveniently situated for working the quick-firing guns, special gear being supplied for hoisting and delivering the ammunition. The importance of this last feature will be recognized when we say that the 6-inch guns have a unit of 200 rounds each, the 12-pounders of 300 rounds, and the 8-inch guns of 150 rounds maintained in the magazines. The axial fire of the Argonaut will be exceptionally heavy, both forward and aft. Forward there will be two 8-inch, four 6-inch, and two 12-pounders capable of being trained in a line with the keel. These can discharge in one minute,

Two 8-in.	quick-firers	4 rounds	1000 lb.	} 3360 lb.
Four 6-in.	"	20 "	2000 "	
Two 12-pounder	"	30 "	360 "	

representing a hitting energy of 122,418 foot-tons.

The propelling machinery of the Argonaut will consist of two sets of triple-expansion engines, each with four inverted cylinders. Each propeller has a boss of gun-metal fitted with three adjustable blades of manganese bronze, constructed to work inwards. Steam will be supplied by thirty water-tube boilers and economizers of the latest Belleville type. The boilers are arranged in four groups, each group fitted in a watertight compartment. The boilers are designed to work at 300 pounds pressure, reducing valves being fitted to bring it down to 250 pounds at the engines. The boilers, in working condition, weigh 720 tons. In the later ships the boiler is divided into two parts; in addition to the "generator" an "economizer" is placed in the path of the escaping hot gases, and much of the heat otherwise lost is utilized in raising the temperature of the feed-water, as it passes through the economizer tubes to the generator below. There is a space between the lower series of tubes forming the generator and the upper series forming the economizer; and a supply of air is forced into this space, to ensure the combustion of the gases. The passing of the feed-water through the economizer tubes, it was found by land trials, raised the temperature from 68 degrees Fah. to 226 degrees under ordinary conditions, and to 330 degrees when the boiler was pressed. At the same time the temperature of the gases was reduced by more than half in its passage through the economizer tubes, from 860 degrees to 394 under ordinary conditions, and from 1560 degrees to 750 when the boiler was pressed. A speed of 20¾ knots per hour is expected, with 18,000 indicated horse-power.

The Argonaut will be rigged with two light masts, each fitted with a platform, or light top, for operating electric search-lights. She has not, however, any arrangement designed for fighting tops to mount quick-firing guns.—*Engineering*.

WOLF.

The torpedo-boat destroyer Wolf, built by Messrs. Laird Brothers, Birkenhead, went out on December 30, 1897, on the Clyde for her official full-power coal-consumption trial with satisfactory results, the mean speed obtained on six runs over the measured mile being 30.3 knots with 370

revolutions, and the speed for three hours' run 30.11 knots. On January 6 she went out for her official full-power coal-consumption trial with satisfactory results, the mean speed obtained on six runs over the measured mile being 30.3 knots, with 370 revolutions, and the speed for three hours' run 30.11 knots.

FLYING FISH.

The Flying Fish, torpedo-boat destroyer, built and engined by the Palmer Shipbuilding Company, had her initial three hours' coal-consumption trial on the 25th February. The mean of six runs over the measured mile in Stokes Bay gave her a speed of 30.361 knots, with 390.7 revolutions a minute, while with 393 revolutions for the three hours the speed by patent log was 30.484 knots. The indicated horse-power on the mile was 6431, and for the three hours 6457, showing remarkable uniformity in both phases of the trial. There was an abundance of steam throughout the run.

VIOLET.

The Violet, torpedo-boat destroyer, had a 12 hours' economical coal-consumption trial at Portsmouth on February 23. She was required to steam at 13 knots with a coal consumption not exceeding 1 ton per 30 miles. The mean speed of the 12 hours was 13.008 knots, and the consumption 1.99 lb. per unit of power per hour. The average worked out at 36½ miles per ton of coal, and, as the vessel carries 84 tons of fuel, this gives her a radius at economical speed of 3066 miles.

GIPSY.

The Fairfield Shipbuilding and Engineering Company, Limited, have completed the official trials of H. M. S. Gipsy, the first of the 30-knot torpedo-boat destroyers built by them for the British Admiralty, with most satisfactory results. The speed on six runs over the measured mile at Skelmorlie was as follows: 29.851 knots, 29.607 knots, 30.456 knots, 30.151 knots, 30.456 knots, and 30.354 knots; giving a mean of 30.176 knots. On a subsequent trial of three hours' continuous steaming the mean speed was 30.207 knots.

BULLFINCH.

On February 10th H. M. S. Bullfinch, 30-knot torpedo-boat destroyer, was launched at Hull from the yard of Earle's Shipbuilding and Engineering Company, Limited, and may shortly be expected to be ready for her official trials, as her machinery is nearing completion, and her boilers were on board at the time of launching.

SEAL.

The Seal, torpedo-boat destroyer, built by Messrs. Laird Brothers, Birkenhead, went out on the Clyde on January 3rd on her official full-power coal-consumption trial with the following satisfactory results: Speed on mile 30.04 knots with 370.5 revolutions, and speed on three hours' run 30.02 knots.

LOCUST.

H. M. S. Locust, torpedo-boat destroyer, built by Messrs. Laird Brothers, Birkenhead, went out on the 21st February for her official full-power coal-consumption trial at 30 knots, with very satisfactory results. The speed realized on six runs on the measured mile at Skelmorlie was 30.26 knots. And for three hours' continuous steaming, 30.15 knots. Her sister ship, the Seal, completed her series of trials on the 24th Feb., in the presence of the Admiralty representatives. Her official full-speed trial was commenced shortly after 10 a. m., and a speed of 30.79 knots was obtained as a mean of the six runs on the measured mile. The mean speed for the first four miles was 31.03 knots, equivalent to $36\frac{1}{4}$ miles per hour. The speed for the three hours' continuous steaming was 30.15 knots. After the completion of this trial the usual steering trials at full speed ahead and astern were carried out satisfactorily and successfully, and the stopping, starting and reversing of the engines demonstrated their efficiency.

[FRANCE.]

BUILDING PROGRAM.

The following is the building program as at present settled for 1898: At Brest, a first-class battle-ship A9; at Cherbourg, a first-class armored cruiser C4; at Lorient, a first-class armored cruiser C7. To be built by contract: One first-class armored cruiser C8, of 9517 tons, to be a sister ship to the Montcalm; two first-class armored cruisers, ex-D4 and ex-D5, of 7700 tons, to be called the Desaix and Kleber; five torpilleurs-de-haute-mer and six first-class torpedo-boats.

The total number of new vessels completing, building and to be laid down is 84, divided as follows: 8 first-class battle-ships, 10 first-class armored cruisers, 4 first-class station cruisers, 3 second-class cruisers, 3 third-class cruisers, 1 first-class aviso, 10 torpedo-boat destroyers, 6 sea-going torpedo-boats, 36 first-class torpedo-boats, 1 submarine torpedo-boat, 1 gunboat, 1 gunboat launch. Of these numbers, 61 are actually under construction in government and private yards, leaving 23 to be commenced before the end of 1898.

The new battle-ship to be built at Brest is to have a displacement of 12,000 tons, but her plans are not yet completed. It is intended to lay down the Kleber and Desaix before the end of this year, if possible, but the contracts have not yet been signed. Their dimensions will be as follows: Displacement, 7700 tons; length, 422 feet 6 inches; beam, 58 feet; engines and boilers of the same system as Montcalm class; H. P., 17,100; speed, 21 knots; coal stowage, 5200 tons; radius of action at 10 knots, 8800 miles; radius of action at full speed, 1650 miles; armament, ten 16.4-centimetre (6.3-inch), ten 3-pounder and six 1-pounder Q. F. guns, with two above-water torpedo discharges. The station cruiser to be built at Rochefort will have a displacement of about 5000 tons, but the plans are not yet completed.

The destroyer Yatagan will be similar to the Pique, Epee and Framee, namely: displacement, 303 tons; H. P., 4800; speed, 26 knots; armament, one 65-millimetre and six 47-millimetre Q. F. guns; two above-water torpedo tubes. The designs for the five sea-going torpedo-boats are not yet completed, but they will have a displacement of about 150 tons. The six first-class torpedo-boats will have a displacement of 84 tons and a

speed of 23 knots. Armament, two 37-millimetre guns and two torpedo tubes.

The plans of the new battle-ships and cruisers are all due to M. Bertin, head of the Section Technique des Constructions Navales, who will be held responsible. This is a new departure, as up to the present no definite responsibility for the ship designs was attached to any single official.—*Journal of the Royal United Service Institution.*

A first-class armored cruiser, to be called the Dupleix, has been laid down at Rochefort, replacing the cruiser "D3," of 5500 tons, which figured in the budget vote of 1897. The Dupleix will have a displacement of 7700 tons, vertical triple-expansion engines, multitubular boilers, three propellers, and an estimated speed of 21 knots. Her armament will consist of ten 16.4 centimetre (6.3-inch), ten pounder, and six 1-pounder Q. F. guns, and two above-water torpedo discharges. Her cost will be 15,500,000 francs, and she will practically be a sister ship to the Kleber and Desaix.—*Journal of the Royal United Service Institution.*

[ITALY.]

SHIPS UNDER CONSTRUCTION.

The naval estimates for 1898 and 1899 amount to 105,963,646 lire, but as some deductions have to be made, the real total is 94,769,124 lire, of which 24 millions and a half are devoted to the personnel and 19,500,000 lire to new constructions and completing during the current year the following ships: First-class battle-ships—Emanuele Filiberto, completing at Naples, and Ammiraglio di Saint Bon at Venice. First-class armored cruisers—Vettor Pisani, completing at Naples; Giuseppe Garibaldi, completing at the Ansaldo Works, Sestri Ponente; Varese, completing at the Orlando Yard at Leghorn. Second-class ram cruiser—Puglia, fitting out at the dockyard at Taranto. Torpedo cruisers—Agordat and Ciotat, building at Naples and Castellamare respectively.

At Castellamare a new torpedo cruiser of the Agordat type is to be laid down, besides some torpedo-boat destroyers and torpedo-boats, but with regard to the proposed new battle-ships no decision as to their type would appear to have been yet arrived at, although it is stated that four are to be laid down. By the end of the financial year, 1st July, 1899, the active fleet will consist of 320 vessels of all classes, 51 of which will be battle-ships and cruisers and 146 torpedo-boats.—*Journal of the Royal United Service Institution.*

The Duilio is refitting at Spezia, same as the Dandolo. She is to receive a new armament, new boilers and engines, to give a speed of 18 knots. If these changes come up to expectations all the older ships are to be similarly refitted and rebuilt.

[JAPAN.]

AKASHI.

The latest papers from the Far East bring an account of the launch at the Yokoska shipbuilding yard of the cruiser Akashi, a sister vessel, we believe, to the Suma, which was launched from the same yard about

two years ago. The Yokoska shipbuilding yard, which is situated a few miles below Yokohama, was under the charge of French engineers and shipbuilders for a good many years, but now it is entirely managed by Japanese, who, after having studied in their own country, extended their practical knowledge in some of the largest shipbuilding yards in Europe.

The Akashi is a steel twin-screw cruiser of 295 feet in length, 41 feet 7½ inches in beam, 15 feet 8½ inches in draught, 2800 tons displacement, and 8000 horse-power. It is expected that she will attain a speed of 19½ knots. Her coal bunkers have a capacity for 600 tons, and her armament, when completed, will consist of six 12-centimetre quick-firing guns, two 15-centimetre quick-firers, four machine guns, and two torpedo-tubes; the six 12-centimetre in sponsons, three of which are constructed on either side of the ship, the two 15-centimetre guns being mounted behind shields, fore and aft. The difficulty of shipbuilding in Japan, especially for the navy, will be understood when it is remembered that practically all the steel used in construction requires to be imported, and therefore that much of the special work which engineers and shipbuilders in this country get done at outside establishments, requires to be done in the yard at Yokoska.—*Engineering*.

KASAGI AND CHITOSE.

This protected cruiser was successfully launched at Cramp's shipyard, January 20th. She is the first foreign warship launched in America for twenty years. Two days later the Chitose, building at the Union Iron Works, San Francisco, was launched. The Kasagi is modeled on the lines of the fast and powerfully armed protected cruisers which have been built by Armstrong, of England, for the Japanese and other foreign navies. She is 396 feet long, with 49 feet of beam and a draught of 17 feet 9 inches, her displacement at this draught being 4900 tons. The motive power is supplied by two vertical, inverted, triple-expansion, four-cylinder engines, driving twin screws, and estimated to develop, under forced draught, a mean speed of 22½ knots per hour. The engines are of 17,000 horse-power, and the boiler-rooms contain twelve single-ended boilers, 14 feet 2 inches in diameter and 9 feet 9 inches in length. She will carry enough coal to cruise for 4000 miles at 10 knots an hour. In the specifications she is classed as a protected cruiser of the second class, and like all vessels of her type has no defensive armor, relying on her coal bunkers, which run 108 feet fore and aft of her amidship section, to protect her engines, which are entirely below the water-line. Above these is a protective deck, having a maximum thickness of 4½ inches on the slopes and 1¾ inches on the flat, giving ample protection to the vital parts of the ship.

The batteries of the Kasagi are heavier than those on either the United States cruisers Minneapolis or Columbia, and it is alleged that the new cruiser, because of her superior protection, will have greater defensive and offensive power. There are no turrets on the Kasagi, but she will be quite well protected by guns. There are two 8-inch rifles at the sides, and her armament besides will consist of ten 4.7-inch quick-firing rifles mounted in broadside, a secondary battery of twelve 12-pounder quick-firing rifles, and six 2½-inch Hotchkiss guns. The 8-inch rapid-fire guns have a speed of fire three times that of the old slow-firing type, so that these two guns alone would equal the six 8-inch guns carried on our own New York, a ship of 8000 tons displacement. As the energy of each

shell from the New York's 8-inch guns is 7498 foot-tons and that of the shells from the Kasagi's 8-inch guns is 10,662 foot-tons, we see what an enormous advantage is gained by the adoption of the rapid-fire system. In the present instance it brings the offensive power of a 4900-ton ship up to and beyond that of an 8000-ton ship. This comparison is an important commentary upon the urgent plea of Assistant Secretary of the Navy Roosevelt for the arming of our cruisers with guns of the rapid-fire type.

NEW JAPANESE WAR VESSELS.

In addition to the new second-class cruisers, Kasagi and Chitose, building in this country, Japan is having built at various places nearly forty battle-ships, armored cruisers, protected cruisers, torpedo-boats and torpedo-boat destroyers. These include three 14,800-ton battle-ships, which are well advanced at Armstrong's, Thompson's and the Thames Iron Works, respectively, in England; one battle-ship of about 10,000 tons, also under way at Armstrong's; four first-class armored cruisers of 9600 tons displacement and twenty knots speed—two of these at Armstrong's, one at the Vulcan Works, Stettin, Germany, and one at Forges et Chantiers, France; one protected cruiser of 4300 tons and about twenty-three knots speed at Armstrong's; four thirty-knot torpedo-boat destroyers at Yarrow's, England, and four more of a similar type at Thompson's; eight ninety-ton torpedo-boats at the Schichau Works, Elbing, Germany, and four more of a similar type at the Normand Works, France; three 3000-ton protected cruisers of twenty knots, three torpedo gunboats and a dispatch vessel at the Imperial dockyards, Yokosuka, Japan, and an armored cruiser of 9600 tons and twenty knots, to be also built at Yokosuka. All of these vessels are expected to be completed by 1903.

[PORTUGAL.]

ADAMASTOR.

The latest addition to the Royal Portuguese Navy is the twin-screw cruiser Adamastor, which performed her speed trials and was accepted in July, 1897. The ship was built and engined by Orlando Brothers, of Leghorn; her general dimensions are as follows, viz.: Length, between perpendiculars, 242 feet 2 inches (73.810 m.); length, over all, 261 feet (79.622 m.); breadth, 35 feet 2 inches (10.730 m.); depth, moulded, 21 feet 4½ inches (6.500 m.); normal displacement, 1765 metric tons; displacement, with 419 tons of coal on board, 1962 tons. The hull is of steel and is partially double bottomed. The whole is divided into twenty-three main water-tight compartments, and the lower deck is of steel with water-tight doors.

The armament consists of two 15-cm. Krupp guns, placed one on the topgallant forecastle and one on the raised quarterdeck; four quick-firing 10.5-cm. and four quick-firing 6.5-cm. Krupp guns on the main deck; two 37 mm. Hotchkiss guns on the bridge; two 6.5 mm. Nordenfeldt machine guns on the fighting tops. Besides, there are three torpedo tubes, one forward and two on the broadside on the main deck.

The conning tower is of steel, 2½ inches thick. There are six boats, one of which is a steam launch. On the quarterdeck there is a very elegant state-room; the chief commander's bed, drawing and bath rooms; the second commander's bed and bath rooms; the pantry, the chart room,

&c. &c. The officers' accommodation is aft, but under the main deck; the officers' mess-room, which is near the midshipmen's mess-room and cabins, extends the full breadth of the ship. The topgallant forecabin is occupied by petty officers' cabins and sailors.

Great care was taken in ventilating the ship with natural draught; but besides this, two electric ventilators, 4 feet in diameter, are provided for use in hot climates, and they blow the fresh air, not only into every cabin, but also into the store-rooms, steering engine-room and magazines. The vessel is propelled by two triple-expansion engines, designed to develop 4000 indicated horse-power, placed in separate water-tight compartments, the high-pressure cylinders being forward; the bed plates, the cylinder frames, which are of the inverted Y form, as well as the covers of the cylinders and valve chests, are of cast steel. The cylinders' diameters are: High-pressure, $23\frac{1}{4}$ inches (0.59 m.); intermediate, $37\frac{3}{8}$ inches (0.95 m.); low pressure, $59\frac{1}{2}$ inches (1.50 m.). The common stroke is $31\frac{1}{2}$ inches (0.80 m.). The main condensers are in the wings—they are cylindrical—and built with Muntz sheets; the total combined condensing area is 4862 square feet. The propellers are of Delta metal, three-bladed, 10 feet $11\frac{1}{4}$ inches in diameter (3.340 m.), the projected surface of each propeller being of 30.66 square feet (2.85 m. q.). Steam is supplied by four marine single-ended boilers, placed in separate water-tight compartments; they are 13 feet $6\frac{7}{8}$ inches in diameter and 12 feet $3\frac{1}{2}$ inches long, with three Fox's furnaces, each 3 feet $7\frac{1}{8}$ inches mean diameter. The total heating surface is 8823 square feet (8.20 m. q.); the total grate area is 262 square feet. The working pressure is 160 lbs. per square inch. Four ventilating tubes, $39\frac{1}{2}$ inches in diameter, supply air to the boilers at natural draught, and four ventilating fans, 5 feet 3 inches (1.600 m.) in diameter, are provided for the forced draught, which is on the closed ashpit system. One auxiliary boiler, having 223 square feet of heating surface, is placed on the main deck. A very complete system of pumping arrangement is fitted, and we may mention the two 500 tons per hour centrifugal pumps, the bilge and auxiliary pumps, capable of pumping overboard 100 tons of water per hour, and the two 50 tons each steam ejectors.

Three trials were to be made. The contract speed at natural draught, six hours' trial, was to be 16 knots, with 115 revolutions and 3000 indicated horse-power the main engines. The official results of this first trial, made on the 28th June, 1897, are: Mean speed, 17.19 knots; mean revolutions 119, with a maximum of 122; indicated horse-power varying from 2900 to 3100. On the following six hours' trial, at 10 knots speed, the coal consumption was not to exceed 154 lbs. (70 kilos.) per mile. The trial was made on 30th June; the power developed by the main engines, running at 67 revolutions, corresponding to 10-mile speed, was 523, and the coal consumption in the six hours was 4629 lbs. (2100 kilos.), that is, 77 lbs. per mile, or 1.45 lb. per indicated horse-power.

The coal capacity of the bunkers being of 419 tons, the radius of the Adamastor at 10 knots speed is at least 8896 miles, including the coal consumption of the galley, water-distilling apparatus, etc.

The two hours' forced-draught trial was to give a speed of 17.3 knots with 130 revolutions of the main engines and 4000 indicated horse-power. The trial was made on the 8th of July, on which occasion the photograph of the vessel at sea, reproduced as our supplement this week, was taken, with the following results: speed, mean, 18.04 knots; revolutions, 131.5; mean indicated horse-power, 4030; steam pressure in the boilers varying

from 156 lbs. to 160 lbs.; air pressure in the ashpits, $\frac{7}{8}$ inch of water. The engines as well as the boilers worked during all the trials in the most satisfactory manner, no part of the engines getting heated, nor was there any priming.

The Adamastor's electric plant consists of two 4-pole dynamos, directly coupled to the vertical single cylinder double-acting engines, 8 inches in diameter, with $5\frac{1}{2}$ -inch stroke, working at 275 revolutions per minute. The current output of each dynamo is 110 ampères, at 65 volts. There are 190 lamps through the ship, and two 16-inch diameter, 50-ampère, search-lights on the mast.—*Engineer*.

DON CARLOS I.

An armored cruiser, Don Carlos I., of 4100 tons displacement, is building in England for the Portuguese government. The armored deck to have a thickness of $1\frac{1}{2}$ to 4 inches. Two triple-expansion engines, steam supplied by water tubular boilers, are to give a speed of 22 to 23 knots under forced draught. Coal capacity 1000 tons, giving a radius of action of 10,000 miles at 12 to 13 knots. The armament, entirely of rapid-fire guns, comprises two 7.8-inch and ten 4.7-inch guns, protected by 3-inch gun shields; twelve 47-mm. and six 37-mm. guns, besides four Maxim machine guns. There will be five torpedo tubes, three being submerged.—*Moniteur de la Flotte*.

GUNBOATS.

Two gunboats, Almirante Baptista de Andrade and Thomaz Andoa, of 220 tons each and 10 to 12 knots speed, are building. They are to be armed with small rapid-fire guns.

[RUSSIA.]

SHIPS UNDER CONSTRUCTION.

It is stated that the naval estimates for the coming year, when published, show an increase of 6,000,000 roubles on those of last year, and that the credit allotted for the construction of new warships will amount to 24,800,000 roubles, and attempts will be made to carry out the building much more speedily than heretofore. At present a large armored cruiser of the type of the *Rossia* is being constructed at the Baltic Works on the Neva; she will have three engines and three propellers, and the engines are to develop a total of 18,000 I. H. P. In the same yard two torpedo destroyers of the type of the *Sokol* are being built; their hulls will be of nickel steel, and their engines will develop about 4400 I. H. P., and they are intended to be in all respects superior to the *Hornet*, and in some minor points improvements on the *Sokol*. In Abo, at the works of Greighton and Co., two more torpedo destroyers of the same type are in process of construction. In the Admiralty Works at Ijora a battleship of 12,674 tons displacement, 434 feet long and 26 feet draught, of the type of the *Oslabija*, is being built, and no less than twenty-four torpedo destroyers of the *Sokol* type. Of these, twelve will be taken in parts to the port of Vladivostock and twelve will be left in the Baltic port. A lightship for Nekmangrund and another for Port Nikolaieff in the Black Sea have also been ordered at the same place. An armored ship of 8800 tons displacement and 341 feet long, of the type of the

Rostislav, is to be built at Nikolaieff for the Black Sea fleet. In the same works a battle-ship of 12,480 tons displacement and 357 feet long, of the type of the Three Saints (Tri Sviatitelya), will shortly be laid down. Further, engines are now being made for the unchristened cruiser of the type *Rossia* (18,000 I. H. P.), for the new cruiser of the type *Pallada* (11,610 I. H. P.), for the cruisers *Diana* and *Aurora* (11,610 I. H. P.), for the armored turret-ship *Peresjet* (14,500 I. H. P.), for the *Oslabija* (14,500 I. H. P.), and for the barbette ship of the type of the *Tri Sviatitelya* (10,600 I. H. P.).

The Ministry of Marine has decided to provide next year the following guns: Twenty-five 12-inch, 40 calibres in length; sixteen 10-inch, 45 calibres long; one 8-inch; forty-nine 6-inch Q. F. guns; twenty-three 120-mm. Q. F. guns; a hundred 75-mm. Q. F. guns; eight *Baranovsky* 2½-inch guns; 134 *Hotchkiss* 47-mm. guns; and ninety-six *Hotchkiss* 37-mm. guns. In addition, hydraulic carriages will be built for the 12-inch and 10-inch guns, turret mounts for the 6-inch pieces, and fixed carriages for the others. The Admiralty has also ordered 100 *Whiteheads* (new model), ninety-six 19-foot *Whiteheads*, and twenty 45-cm. torpedoes. 112,000 roubles are to be expended on hand torpedoes and 87,000 roubles on electric naval mines and mining material. For the vessels in commission, 11,184,371 roubles; provisions, 6,946,906 roubles; guns and torpedoes, 5,089,296 roubles; workshops and offices, 4,487,556 roubles; for improvements in the port of Vladivostock, 6,000,000 roubles.—*Journal of the Royal United Service Institution.*

The Russian Admiralty has decided to replace the "Du Temple" boilers of torpedo-boats Nos. 125 and 126 by *Yarrow* straight-tube boilers, owing, it is said, to the rapid deterioration of the tubes of the former boilers—due, we are told, to their curved shape, and also because the *Yarrow* boilers allow of a larger heating surface.

[SPAIN.]

CRISTOBAL COLON.

It will be remembered that one of the six vessels in the last Italian naval programme (which dates so far back as 1891) was named the *Giuseppe Garibaldi*. She was to be built and engined complete by Messrs. *Ansaldo and Co.*, of *Sestri Ponente* and *Sampierdarena*, near *Genoa*, and she was to be delivered within six years. But the capacity of the *Ansaldo's* works is such that the construction of the engines was completed and the ship ready for launching within 22 months.

It was just at this time that the Argentine Republic, having one of those perennial differences of opinion with its sister republic of *Chili*, was looking about for warships to add to its fleet as an answer to the threatening armament that *Chili* was gradually accumulating, and overtures were made to the Italian Government for the purchase of the *Giuseppe Garibaldi*. It was then arranged that Messrs. *Ansaldo* should have power to dispose of the vessel to Argentina on the condition that the second one should be delivered to the Italian government within the time originally stipulated for the first one; and with the further proviso that in consideration of the granting of such a favor Messrs. *Ansaldo* were to fit the new vessel with water-tube boilers, in place of the cylindrical ones provided for the original vessel, and that all materials for the new ship should be obtained in the kingdom of Italy as far as possible.

The name Garibaldi was retained for the Argentine vessel in recognition of all that that hero did for Argentina, and the vessel was speedily completed and handed over to the Argentine authorities. The fitting the machinery on board was a remarkably smart piece of work for any country, the engines and boilers being ready for their steam trials ten weeks after the vessel was launched. The keel of the second ship was laid on September 25, 1895, and her construction so pushed forward that there was every probability that it also would be ready for sea long before the time originally stipulated. It was at this juncture that Spain, seeing the urgent necessity of adding to her fleet some modern and really serviceable vessels, decided to purchase the Garibaldi No. 2 if it were possible, and the Italian government was again approached with a request for the cession of the second vessel. This was again granted on the same terms as before, but with a distinct warning from the Italian Ministry of Marine that on no account would any extension of time for final delivery be granted, and any fines for delay would be most strictly enforced. The launch of this second vessel took place on September 16, 1896, and was made the occasion of a most remarkable outburst of enthusiasm and scene of fraternization between the Spanish and Italian peoples. A large steamer was chartered and sent to Barcelona for representatives of all the principal Spanish newspapers, and these journalists had public receptions and festivities in their honor wherever they went. The vessel left the ways in the presence of cheering thousands, and was named Cristobal Colon by Madame Benomar, the wife of the Spanish ambassador to the court of Italy.

The leading dimensions of the vessel are as follows: Length, 328 feet; beam, 59 feet 9 inches; and draught, 23 feet 3 inches, at which the displacement is 6840 tons. The armament consists of two 25-centimetre guns placed at either end of the vessel en barbette, ten 15-centimetre, six 12-centimetre, ten 57-millimetre, and ten 37-millimetre guns, all, with the exception of the two large guns, being quick-firing. There are also two machine guns and two light guns with their carriages for use on shore.

The propelling machinery consists of two sets of triple-expansion inverted engines having cylinders 42 inches, 63 inches, and 93 inches in diameter respectively, with a stroke of 3 feet 10 inches. Each cylinder is supported by four cast-steel columns with cast-iron crosshead guides bolted on their faces and standing on cast-steel main bearing frames. The high-pressure cylinders are fitted with piston valves, while the intermediate and low-pressure cylinders have double-ported slide valves, all being worked by double eccentrics and Stephenson's link motion. The piston-rods, connecting-rods and shafts are of steel, these latter being hollow throughout, and the crankshaft being made in three parts interchangeable. The condensers, two in number, are of delta metal, and are fitted with horizontal tubes through which the water passes, and have a cooling surface of 14,600 square feet. There are two single-acting air-pumps made of gun metal 33 inches in diameter and 21 inches stroke, worked by beams from the low-pressure cylinder crossheads. There are two large centrifugal pumps, each worked by a compound engine, and each is fitted with a small auxiliary single-acting air pump for the purpose of maintaining a vacuum and keeping the main condensers free of water when the main engines are stopped. An auxiliary condenser is fitted in each engine-room, having its special circulating and air pump.

Messrs. Maudslay's latest arrangement with secondary tanks for maintaining a constant head of water against the suction valves of the feed pumps was adopted, and was found to give admirable results on the trials.

The steam-producing apparatus consists of 12 water-tube boilers of the Niclausse type, which were made in Paris. The boilers are placed back to back against the central bulkhead, three in each compartment, and a funnel is provided for each group of six boilers.

The vessel was ready for trial in March, 1897, the official natural-draught trial taking place on April 29, 1897, when the results exceeded every expectation. The boilers gave such an ample supply of steam that the full contract speed of the vessel was obtained without even putting the fans in motion. At the three hours' trial, with a mean pressure of 57.04 lbs. in the high-pressure cylinders, a vacuum of 28.2 inches, the two engines developed a collective indicated horse-power of 10,671, exceeding by 2071 I. H. P. that required by contract.

As is usual on trials with ships fitted with water-tube boilers, the firing was done regularly, each furnace being charged with a certain amount of fuel at stated intervals, a clock being fitted in each stokehold to facilitate this.

The mean speed on this trial, on a long base, was 19.35 knots, and as this was in excess of the contract speed, the commission appointed by the Spanish government to receive the vessel decided that no further full-speed trial was necessary.

Besides the substitution of water-tube boilers and the application of hotwell pumps with their tanks and service of pipes, the second vessel possesses many other improvements, which were found desirable or necessary from experience with the first Garibaldi.—*Engineering*.

[UNITED STATES.]

THE LATEST BATTLE-SHIPS FOR THE UNITED STATES NAVY.

The latest report furnished to Chief Constructor Hichborn, showing the progress which is being made in the construction of the five battle-ships which are building in private yards for the United States Navy, shows that the Kearsarge and Kentucky are more than half completed, and that from 32 to 39 per cent of the work has been accomplished on the Alabama, Illinois and Wisconsin.

These five vessels, all of which will be first-class seagoing battle-ships, belong to two different types, the first of which, authorized in the year 1895, includes two twin ships, the Kearsarge and the Kentucky, which are building at Newport News; the other type, authorized in the following year, consists of the Alabama, building at the Cramps' yard, the Illinois, at Newport News, and the Wisconsin, which is being constructed at the Union Iron Works, San Francisco.

They differ considerably from each other and from the class of ships which preceded them, represented by the Indiana, Massachusetts and Oregon. They represent the advance which has taken place in battle-ship design since the year 1890, when the Indiana class was authorized, and in the Alabama we have embodied those features of high freeboard, widely separated main battery and broadside secondary battery of rapid-fire guns which are likely to remain permanent in the navies of the world.

The leading features of the two ships are as follows:

Kentucky.	Alabama.
Water-line length.....368 ft.	368 ft.
Beam..... 72 " $2\frac{1}{2}$ in.	72 " $2\frac{1}{2}$ in.
Draught..... 23 " 6 "	23 " 6 "
Freeboard forward..... 14 " 3 "	20 " "
" aft..... 13 " 3 "	13 " 3 "
Displacement..... 11,525 tons	11,520 tons
Speed 16 knots	16 knots
Coal supply 410 tons	800 tons
Horse power..... 10,000	10,000
Armor, nickel steel.	
Water-line belt..... 16 $\frac{1}{2}$ in.	16 $\frac{1}{2}$ in.
Side armor above belt.... 6 "	5 $\frac{1}{2}$ "
Turret armor .. 17 and 15 "	17 and 15 "
Barbette armor 15 "	15 " 10 "
Conning tower..... 10 "	10 "
Protective deck..... $2\frac{3}{4}$ "	$2\frac{1}{2}$ to 4 "
Armament.	
Main battery..... 4 13-in. guns	4 13-in. guns.
Submain battery .. 4 8-in. guns	
Secondary battery, 14 5-in. R. F. guns	14 6-in. R. F. guns.
20 6-pdr. R. F. guns	17 6-pdr. R. F. guns.
	6 1-pdr. R. F. guns.

If it is compared with the Indiana it will be evident that the greatest change in the Kentucky is in the novel method adopted for carrying the 8-inch guns. In the Indiana there were eight of these disposed in four turrets, at the four corners of the central armored battery. By this arrangement it was hoped to be able to train four guns on either beam or directly ahead. In the gunnery trials, however, it was found that if these guns were fired direct ahead or astern their blast rendered the sighting-hoods of the 13-inch guns untenable. To prevent this "interference," as it is called, the double-deck turrets were adopted. They constitute the most striking feature in these ships; nothing like it has ever been attempted before and it is not likely that it ever will be again. As far as the danger of interference is concerned, the device is likely to prove a success. The muzzles of the 8-inch guns project well beyond the sighting-hoods of the 13-inch gun turret below it, and no serious effects will probably be felt by the men stationed within them. It will be noticed, moreover, that the Kentucky will be able to bring the same number of 8-inch guns to bear in any direction as the Indiana, that is, two ahead or astern, and four on either beam; in fact, owing to the inability of the 8-inch guns of the Indiana to be fired dead ahead or dead astern, the four 8-inch guns of the Kentucky may be said to be more efficient than the eight similar guns on the Indiana. The great weight of two turrets and four guns with their ammunition is thus saved and can be put to other uses.

We have said that it is not likely that any more double-deck turrets will be built. The reason for this is the objection which naval designers feel to putting "too many eggs into one basket." It is an accepted axiom in warship design that the various gun stations of a ship should be as widely separated as possible, with a view to localizing the damage inflicted by a successful shot.

If the lower half of a double-deck turret should be crippled, the upper turret would also be placed *hors de combat*, and a light shell which was incapable of penetrating the 15-inch armor of the lower turret might pass through the 9-inch armor of the upper turret and wreck the turning gear below, thereby disabling the four guns. There is a further objection urged by the gunners in the fact that the two sets of guns must be trained together, whereas it might frequently be desirable in the course of a fight to train the 13-inch guns upon one part of the enemy and the lighter guns upon some other part. The whole question, however, was well thrashed out by the experts at the time the ships were designed, and it was considered that the economy in weight and machinery more than offset the objections which were raised against the system.

Next to the turrets the most novel feature in these ships is the powerful broadside battery of fourteen 5-inch rapid-fire guns which it has been possible to substitute for the four 8-inch guns and turrets and the four slow-firing 6-inch guns of the *Indiana*. This battery is ranged within a central battery on the main deck between the two turrets. There are seven guns on each broadside, each gun firing through an arc of 90 degrees. Though the shell for the 5-inch gun weighs only 50 pounds as against 250 pounds for the shell of the 8-inch gun, so great is the rapidity of fire from the former gun that three times the weight of metal will be thrown in a given time from the rapid-fire battery. The gunners will be protected by 6 inches of harveyized steel.

On the deck above will be another battery of twelve 6-pounder guns, and eight others will be located forward and aft on the berth deck. It will be the work of these guns to repel the attack of the torpedo-boats. A number of 1-pounders and Gatlings will be carried in the tops of the military masts.—*Scientific American*.

BOOK NOTICE.

ALL THE WORLD'S FIGHTING SHIPS, by Fred. T. Jane, published in this country by Little, Brown & Co., of Boston, will probably prove to be a valuable addition to naval literature. The book shows an endless amount of care in its preparation and is full of information. It contains descriptions and cuts of nearly all, if not all, of the fighting ships of the prominent nations. The cuts and data are admirably arranged for easy reference, and ships of all nations are classified according to their fighting and defensive power, into armored ships, of which there are five classes; then into eight classes of unarmored ships. The classification and arrangement are easy to understand and well suited to a book for general information. The data and descriptions are published in English, French, German and Italian. In the case of armored ships carrying vertical armor, small plans of the ships are given, showing the arrangement of the armor. For the whole work the author deserves great credit and the thanks of every one seeking information concerning the navies of the world.

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MARCH. Strategic View of the Mediterranean. Contributions to Nautical Astronomy. Electric Steering Engines. Tests of Metals for Tensile Strength and Elongation. Work done in the Imperial Physical Laboratory (spring, 1895, to the summer of 1897). Trials of the Aegir. Kiaotshau. The Occupation of Tshingtau. The German Fleet as viewed from an Oldenburg Standpoint. Naval Notes.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOL. XXVI., No. 2. Statistics on the Growth of the Fleets of Six European Powers. Progress in Armor and Ordnance during 1896. Germany's Programme for Increasing the Fleet. Foreign Naval Notes.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

No. 11, 1897. Hydrographic Reports from the South Pacific. The Comparison between Steamship and Sailing-ship Traffic. Some Points on Thermometers. Determination of Deviation of Compass in Thick Weather. On the Unreliability of Fog-signals on High Coasts. Currents on the Newfoundland Banks. Electric Illumination of Compasses on board Ship.

No. 12. Temperature Observations of Coal Cargo of Bark Madeleine Rickmers on Voyage to East Indies. Typhoon Notes. On Pendulum Observations. Hydrography of Gulf of St. Lawrence. New Storm Signal System on the China Coast. Bottle Posts.

1898, No. 1. Reports on Earthquake Disturbances noted at Sea. Remarkable Storms. Results of Magnetic Observations compared with Theory. Pilot and Towing Charges in Antwerp. Darwin's Theory of Coral Growth.

LE YACHT.

No. 1031, DECEMBER 11, 1897. Speed of Fighting Ships.

M. A. Normand, the eminent engineer, published some time ago an interesting pamphlet with the above title. It brought forth comments from the pens of authorized men like Emile Duboc and Naval Constructor V. G. The letter in this number is an answer to their criticisms and a vindication of M. Normand's theory.

No. 1032, DECEMBER 18. The Naval School on Shore.

Following the examples of England and the United States, a plea is set forth advocating the transfer to land of the school of the Borda from its present position in the roads of Brest.

No. 1033, DECEMBER 25. Re-establishment of the Rank of "Capitaine de Corvette" (lieut.-commander) and Advancement in the Navy.

No. 1035, JANUARY 8, 1898. The Navy and its Rôle in Time of Peace.

No. 1036, JANUARY 15. The War Navies in 1897. Fine Display of Seamanship by our Officers. The Centre-board as a Practice Boat. Conditions of Life on board Men-of-war.

No. 1038, JANUARY 29. The Crisis in the Question of Advancement in the Navy.

No. 1039, FEBRUARY 5. The Navy in Parliament. More about the Rank of Capitaine de Corvette.

No. 1040, FEBRUARY 12. Measurement Formulas for Yachts and Monotypes. The Second-class Armored Battle-ship Alexandra. Tide Signals on the Coasts of France.

No. 1041, FEBRUARY 19. Advancement in the Navy.

In order to obviate in a certain measure the evil of stagnation in the navy, it is proposed (1) to re-establish the rank of capitaine de corvette, (2) to reduce the limit of the age of retirement from 60 to 58 for captains and from 58 to 55 for commanders, (3) to compel the retirement of a certain number of officers, (4) to form a skeleton of fixed residences, meaning a body of officers not in the line of promotion. Some kind of reform has become urgent, owing to an alarming increase of resignations in the navy, 50 during the last three years, according to departmental statistics.
J. L.

REVUE DU CERCLE MILITAIRE.

No. 48, NOVEMBER 27, 1897. Protection of the Coasts and Provisioning of Paris. Employment of Bicyclists in Russia. Actual State of the English Army (cont.).

No. 49, DECEMBER 4. The Army and Navy Universal Exposition in 1900 (cont.). A Note on the Penetration of the Italian Rifle Model of 1891. Actual State of the English Army (cont.).

No. 50, DECEMBER 11, AND No. 51, DECEMBER 18. The Army and Navy Exposition in 1900. Military Situation of Russia as it is and as it should be, etc.

No. 1, JANUARY 1, 1898. The Influence of Number in War.

With this number the Review inaugurates a series of practical military problems to be worked out on special maps. This plan has been conceived for the purpose of putting into actual practice, on paper, the regulations and instructions concerning service in the field. The Review propounds a theme elaborated by a group of officers, with data for a practical solution of the problem, of which a typical solution is given in a subsequent number, permitting a comparison with each officer's individual work.

No. 3, JANUARY 15. A Visit to the Barracks of a French Regiment of Cavalry.

No. 6, FEBRUARY 5. The Combat (a lecture delivered by Lieut.-Colonel Paquin).

NO. 7, FEBRUARY 12. Solution of the First Problem: "Service de sûreté en station" (outpost duty).

NO. 8, FEBRUARY 19. Attack of the various Means of Supply of an Army Corps by Cavalry during Battle. The Combat (cont.).

NO. 9, FEBRUARY 26. Examinations for Admission to the Superior School of War for 1898; a Solution to the "Military Question," with Maps.

LE MONITEUR DE LA FLOTTE.

NO. 49, DECEMBER 4, 1897. Reorganization of the Corps of Naval Inspectors.

NO. 50, DECEMBER 11. A Cruiser Yacht for the President of the French Republic. The Navy in Parliament.

NO. 51, DECEMBER 18. The Re-establishment of the Rank of "Capitaine de Corvette" (lieut.-commander). The Navy in Parliament. For the Security of Navigation.

NO. 52, DECEMBER 25. The Mail Service between New York and Havre.

NO. 1, JANUARY 1, 1898. Neutralization of the Banks of Newfoundland.

NO. 2, JANUARY 8. The Cry for more Cruisers.

NO. 3, JANUARY 15. The Hourst Mission in Africa. The Navy Estimates.

NO. 4, JANUARY 22. The Navy of Japan.

NO. 5, JANUARY 29. The Colonial Army. Battle-ships and Cruisers.

NO. 7, FEBRUARY 12. What is our Navy for?

This is an answer to several criticisms published in newspapers and in pamphlet form in regard to the services expected from the navy.

NO. 8, FEBRUARY 19. Advancement in the Navy. Loss of the Torpedo-boat 133. J. L.

REVUE MARITIME.

NOVEMBER, 1897. Geometry of Diagrams (cont.). Artificial Ventilation studied at the Point of View of its Application to the Destroyer Condor. Circulation of Water in Multitubular Boilers. Searching the Enemy at Sea. Recognition of Belligerents considered in its Bearings to Naval Warfare. Foreign Navies.

DECEMBER. Sixth Contribution to the Geometry of Naval Tactics. Development of War Navies during the Last Decade. A Noiseless Siphon (Exhaust) for Steam Launches. Foreign Navies: Questions of Naval Tactics, by the Russian Vice-Admiral Makaroff.

JANUARY, 1898. A Register to Check Waste Power in Engines: Commandant Baill's Method. A Study of the Hemp and Flax for the Manufacture of Canvas in use in the Navy. An Essay on Phonetic Signals to prevent Collisions at Sea in Thick Weather. An Electric Contrivance to Signal from the Bridge the Direction of the Rotation and the Number of Turns of the Screw. Foreign Navies: Duties of Torpedo-boats, their Stations, and Reconnoitering Signals (trans. from the Italian). J. L.

RIVISTA DI ARTIGLIERIA E GENIO.

NOVEMBER, 1897. Horsemanship of the Field Artillery Recruit. A Study of the Probability of Fire in Coast and Ship Batteries. Characteristics of the Fire of Coast Batteries. The Phenomenon of Vision in connection with the Pointing of the Piece.

DECEMBER. Secondary Ballistic Tables. Lightning Conductors and the New Temporary Way of placing them upon Military Buildings.

JANUARY, 1898. The Supplementary Parameters in Rational Ballistics. Building War Observatories out of Bridge Materials. A Method for Correcting Defects in the Conduct of Coast Battery Fire (with diagram). A Folding Support in the School of Fire of the Russian Infantry. J. L.

RIVISTA MARITTIMA.

DECEMBER, 1897. On Naval Battles. The Proposed Commercial Treaty between the United States and Italy.

JANUARY, 1898. Our Navy Crews. The Speed of Warships. Fourth Contribution to the Naval Kinematics. The State of the Italian Merchant Marine.

FEBRUARY. The Silurus: a Notice on its Speed, its Radius of Action, and on its Destructive Power. The Equipment of the Navy. J. L.

REVISTA TECNOLOGICO-INDUSTRIAL.

OCTOBER, 1897. Railways of Secondary Importance. Considerations on the Distribution of a System of Forces among an additional Number of Props.

NOVEMBER. Railways of Secondary Importance (cont.). Substitution of the Cable System to the Trolley in the System of Tramways in Barcelona. Considerations on the Distribution of, etc.

DECEMBER. Public Lectures of the Society "Tecnológico-Industrial." J. L.

BOLETIN DEL CENTRO NAVAL.

AUGUST-SEPTEMBER, 1897. The Dockyard: its Meaning and its Use. A Plan for Lighting the Coasts of the Argentine Republic. Questions on Naval Strategy.

NOVEMBER. Modern Destroyers. Notes on Ship and Squadron Training. The Next Naval War.

MORSKOI SBORNIK.

No. 9, SEPTEMBER, 1897. The Significance of Sea Power in the History of Nations. English Naval Budget, 1897-8. Turbine Steam Engines. The Launching of Ships. The Preparation of Tables of Deviation of the Compass. The Gyroscopic Horizon (Admiral Fleuriais' System).

Naval Chronicle: Shipbuilding Abroad. Accidents to Ships: Collision of Cruiser Phaeton and Torpedo-boat Thrasher. Ordnance: Sims-Dudley Pneumatic Gun. The Krupp System of Sights with Level. Coast Defense: Protection of the Ports of the South Coast of Great Britain from Torpedo Attacks.

No. 10, OCTOBER. Opinions upon Questions in Naval Tactics. Fleet Organization of the Future. Value of Ordnance in Various Battle Formations. Development of the Mathematical Theory of Shipbuilding from the Time of the Founding of the British Institute of Constructing Engineers. Notes on Ships' Boilers. The Ship-trawl. Navigation Notes.

Naval Chronicle: Shipbuilding Abroad. Accidents to Ships: The Grounding of the English Torpedo Destroyers Thrasher and Lynx. Explosion of Torpedo on board the German Iron-clad Friedrich Karl. Loss of German Torpedo-boat S 267. Ordnance Trials of Hadfield Shells.

No. 11, NOVEMBER. Problems in Naval Strategy. The Blockade of Coasts. The Fighting Value of Ships' Artillery. The Use of Naphtha for Steam Boilers of Warships. Wooden Sheathing of Steel Ships. Metallurgical Notes. Two Years in Australian Waters.

Naval Chronicle: Shipbuilding Abroad. Ordnance: Spanish Obturating Electric Primer, Model 1896.

No. 1, JANUARY, 1898. Historical Sketch of the Russian Marine Infantry. Comparative Strength of the Fleets of the Principal Naval Powers. Ironclads of To-day and of the Future. Ordnance Notes. Recent Improvements in Yarrow and Belleville Boilers. Fifty Years' Existence of the Morskoi Sbornik (1848-1898).

Naval Chronicle: Shipbuilding Abroad. Accidents to Ships: Loss of the Japanese Ironclad Fu-So.

REVIEWERS AND TRANSLATORS.

Lieut.-Comdr. R. R. INGERSOLL, U. S. N.

Lieutenant J. B. BERNADOU, U. S. N.

Professor JULES LEROUX.

Lieutenant H. G. DRESEL, U. S. N.

ANNUAL REPORT OF THE SEC. AND TREAS. OF THE U. S. NAVAL INSTITUTE.

TO THE OFFICERS AND MEMBERS OF THE INSTITUTE:

Gentlemen:—I have the honor to submit the following report
for the year ending December 31, 1897.

ITEMIZED CASH STATEMENT.

RECEIPTS DURING YEAR 1897.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Dues	\$536 08	\$190 83	\$388 70	\$466 65	\$1582 06
Subscriptions	159 71	217 89	147 25	144 30	669 15
Sales	124 25	129 00	37 91	22 47	313 63
Interest on Bonds	208 90	9 00	57 36	9 00	284 26
Advertisements	126 25	20 00	215 00	135 00	496 25
Binding	8 00	5 45	5 00	11 80	30 25
Check on deposits . . . . .	. . .	20 00	. . .	. . .	20 00
Totals	\$1163 19	\$592 17	\$851 22	\$789 02	\$3395 60

EXPENDITURES DURING YEAR 1897.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Printing	\$316 03	\$408 29	\$464 15	\$368 41	\$1556 88
Salaries	300 00	300 00	300 00	300 00	1200 00
Postage	36 35	30 52	35 67	38 97	141 51
Expressage	5 81	1 70	2 90	2 50	12 91
Freight and hauling	3 92	5 46	12 38	3 07	24 83
Binding	41 10	. . .	80 . . .	. . .	41 90
Stationery	1 63	37 75	20 . . .	15 03	54 61
Office expenses	1 00	1 25	. . .	1 25	3 50
Telegrams and telephone Prize	75 . . .	29 . . .	25 . . .	. . .	1 29
Gold Medal and engraving same	100 00 . . .	. . .	. . .	. . .	100 00
Insurance and rent on safe deposit box	17 00 . . .	. . .	. . .	. . .	17 00
Purchase back Nos.	5 00 . . .	6 30 . . .	. . .	. . .	11 30
Cashing check on deposits . . . . .	. . . . .	. . . . .	. . . . .	3 00 . . .	3 00
Totals . . . . .	. . . . .	20 00 . . .	. . . . .	. . . . .	20 00
Totals	\$828 59	\$811 56	\$816 35	\$732 23	\$3188 73

SUMMARY.

Balance of cash unexpended January 1, 1897	\$4241 41
Total receipts for 1897	3395 60
Total available cash, 1897	\$7637 01
Total expenditures, 1897	3188 73
Cash unexpended January 1, 1898	\$4448 28
Cash held to credit of reserve fund	59 14
True balance on hand January 1, 1898	\$4389 14
Bills receivable for dues, 1897	857 89
“ “ “ back dues	950 50
“ “ “ binding	15 00
“ “ “ subscriptions	11 45
“ “ “ sales	80
“ “ “ advertisements	187 50
Value of back numbers (estimated)	2000 00
“ “ Institute property	100 00
	<u>\$8512 28</u>

RESERVE FUND.

United States 4 per cent. Consols, registered	\$900 00
District of Columbia 3.65 per cent. registered bonds	2000 00
“ “ coupon bonds	650 00
	<u>\$3550 00</u>
Cash in bank uninvested	59 14
	<u>\$3609 14</u>

MEMBERSHIP.

The membership to date, January 1, 1898, is as follows: Honorary members, 5; life members, 108; regular members, 566; associate members, 198; total number of members, 876.

During the year 1897 the Institute lost by death and resignations 31 members. 33 new members' names were added to the rolls—19 regular, 14 associate; 1 life member; 1 regular member became a life member—the prize essayist.

MEMBERS DECEASED SINCE LAST REPORT.

Braine, D. L., Rear-Admiral, January 30, 1898.

Worden, John L., Rear-Admiral, October 18, 1897.

Lee, S. P., Rear-Admiral, June 5, 1897.

Calhoun, G. A., Lieutenant, U. S. Navy, April 28, 1897.

Jenkins, F. W., Lieutenant, U. S. Navy, February 15, 1898.

Breckinridge, J. C., Ensign, U. S. Navy, February 11, 1898.

The Institute had on hand at the end of the year the following copies of back numbers of its Proceedings:

Whole No.	Plain.	Bound.	Whole No.	Plain.	Bound.
1	.....110.....	....	43	.....168.....	.... 3
2	.....241.....	....	44	..... 60.....	....10
3	..... 51.....	....	45	..... 42.....	....18
4	.....140.....	....	46	..... 49.....	....19
5	.....118.....	....	47	..... 31.....	....18
6	..... 1.....	....	48	..... 50.....	....18
7	..... 1.....	....	49	..... 18.....	....17
8	..... 31.....	....	50	..... 62.....	....17
9	..... 35.....	....	51	..... 35.....	....18
10	..... 1.....	....	52	..... 55.....	....17
11	.....211.....	....	53	.....160.....	....34
12	..... 50.....	....	54	..... 3.....	.... 4
13	..... 1.....	....	55	..... 55.....	....17
14	..... 2.....	....	56	.....457.....	....51
15	.....	....	57	..... 8.....	....12
16	.....225.....	....	58	..... 2.....	.... 7
17	.....	....	59	..... 15.....	....16
18	.....105.....	....	60	..... 1.....	.... 1
19	.....	....	61	.....190.....	....18
20	.....126.....	1	62	.....140.....	....16
21	.....222.....	1	63	..... 77.....	.... 6
22	.....260.....	1	64	..... 30.....	....18
23	.....177.....	1	65	.....124.....	....18
24	.....187.....	1	66	..... 15.....	....16
25	.....1040.....	40	67	..... 9.....	....15
26	.....212.....	90	68	.....150.....	.... 9
27	.....300.....	27	69	.....156.....	....16
28	..... 2.....	15	70	..... 98.....	....17
29	.....208.....	9	71	..... 26.....	....16
30	.....300.....	27	72	.....237.....	....19
31	..... 35.....	50	73	.....230.....	....19
32	..... 17.....	173	74	.....332.....	....19
33	..... 10.....	162	75	.....227.....	....19
34	..... 1.....	1	76	.....228.....	....19
35	.....139.....	5	77	.....225.....	....18
36	.....278.....	29	78	.....210.....	....18
37	.....200.....	24	79	.....229.....	....18
38	.....248.....	1	80	.....234.....	....18
39	.....235.....	1	81	.....308.....	....18
40	..... 37.....	115	82	.....305.....	....18
41	.....259.....	19	83	.....303.....	....18
42	.....108.....	19	84	.....213.....	....18

1 Vol. X., Part 1, bound in half morocco.

Very respectfully,

H. G. DRESEL,

Lieutenant, U. S. Navy, Secretary and Treasurer.

OFFICERS OF THE INSTITUTE.

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Board of Control.

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Professor N. M. TERRY, A. M., Ph. D.

Lieutenant GEORGE F. COOPER, U. S. Navy (ex-officio).

SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1899.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.
2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1899. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.
3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.
4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.
5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.
6. All essays submitted must be either type-written or copied in a clear and legible hand.
7. The successful competitor will be made a Life Member of the Institute.
8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of the Board of Control.

H. G. DRESEL,
Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *January 1, 1898.*

It would be a grave error to suppose that seamanship played little or no part in these engagements. Its function was a very important one, viz. to bring to bear all the guns, and keep them constantly in action, while keeping the ship in such a position that few or none of the enemy's guns could be worked to advantage. To this end the ship was always manoeuvred to obtain a position for raking fire. But that victory should crown this manoeuvre with success the crew must be trained to the highest state of efficiency, that a hot and deadly fire might be poured upon the enemy during the precious moments that the ship could hold this position.

There was no great difference between the ships of the leading maritime powers in those days. French, English, Spanish and Americans had all turned out fine specimens of naval architecture. So it is to-day. The five or six leading naval powers have battleships and cruisers, torpedo-boats and destroyers, that are nearly evenly matched, sometimes built by the same contractors for different nations.

Those were the days of wooden hulls and 18-pounders; now there is 18 inches of steel armor and a shell weighing half a ton; but no nation can rightfully claim superiority in material to-day with any better reason than one hundred years ago.

No sooner has one power succeeded in perfecting or increasing the efficiency of an armor plate, a gun, or a torpedo, than a similar advance is made by each of the others.

What then will decide the victory of to-morrow? Not the material, for that is evenly matched, but the personnel.

What essential must the personnel possess above all others? They must be well disciplined and trained, to the end that the maximum rapidity of fire attainable with the greatest accuracy may be maintained in the presence of the enemy. The one object, the destruction of the enemy, must be achieved, and that result can only be achieved by "the man behind the gun."

Can we now claim superiority in gunnery over the navies of the world? Have we reached the highest possible state of efficiency in training our men? Have we a carefully selected and trained body of men for this purpose?

A most important step in this direction, and one which the service has long endeavored to make, was recently accomplished. A gunnery ship was detailed for the purpose of training specially

selected men to become expert marksmen with great guns. One hundred men were selected by commanding officers of vessels in the North Atlantic squadron and sent to the Amphitrite for instruction.

As soon as these men have become expert they will be drafted for general service and another detail of men selected for gunnery training.

What are the qualifications that these men should possess, what training receive, and what position hold in general service?

A gun's crew should be selected and trained to serve the gun with the greatest rapidity and fire it as rapidly as is consistent with accuracy.

Observe a turret crew at exercise firing at a target, and note the qualities most needed in the leading men. There is a man, the gun pointer, stationed in the sighting hood, sometimes one for each gun, sometimes one for each turret; he has his eye at the telescope and directs his entire attention to the target. His control of the gun varies in different ships. He always fires the gun; he also usually either elevates or trains it, sometimes he does all of these. His is the master mind, however, that controls the fire. The rest of the crew prepare the gun for his use. When the gun is on the target *he* fires; *his* judgment alone comes into play. He co-ordinates all the variables at work.

What are the requirements to fill this billet? Just one. He must be a good shot. He must hit the target. There is only one way to tell a good marksman, and that is to give him a rifle. If he cannot make a good score with a rifle on shore he certainly never will on board ship with the target dancing all over the field of the telescope. It does not follow that because he has made a good score on shore that he will be a successful gun pointer; he may be too slow in his movements, or be confused by the multiplicity of his duties when trying to get elevation and train to coincide on the target. But if a good gun pointer *can* be obtained it must be from this class.

Consider next the remainder of the turret crew when the gun pointer has delivered his successful shot. Every effort is now made to clean, reload, prime and report the gun ready to be again fired by the gun pointer. To this end the gun captain, while performing certain duties himself, is especially responsible that each man in the crew performs his duties in turn, quickly

and thoroughly, and that no time be lost waiting for the next step in loading; he must then be quick, intelligent, with good command of men and resourceful, so that he may get the best results from the crew, and that any slight mishap may be at once remedied without delay.

Here then are two types of men, having entirely distinct functions to perform and with probably markedly different characteristics—the gun pointer to fire the gun and the gun captain to serve it.

How then are they to be selected and trained for these distinct duties?

Take the one hundred men recently drafted to the gunnery ship. As these men have not been selected on account of any special aptitude as marksmen, the first step is to pick out the best marksmen. For this purpose a series of competitions with 6 mm. Lee rifle should be held on shore. At the end of two weeks' or a month's steady practice the records should be made out in order of merit, and the first half be promoted to acting gun pointers, and exercised in sub-calibre practice at the secondary and auxiliary battery. The remainder to be trained for gun captains. This would consist in instructing them in the duties of all the numbers in a turret crew, the manipulation of all machinery in connection with the turret and the service of the gun. At the end of two weeks' or a month's practice the gun pointers should be again arranged in order of merit and a certain number of them ($\frac{1}{2}$) be selected for turret gun pointers, and be drilled in sub-calibre practice with the turret guns. All of this practice to be stationary.

The men would now be arranged in order of merit for turret gun pointers, secondary and auxiliary gun pointers, and gun captains.

Men failing to qualify for gun captains to be returned to general service in the rating in which they were received.

Having now selected and sorted out the men, there remains only practice and plenty of it to perfect their marksmanship.

The practice should be progressive and instructive. For a month daily practice should be held, firing at a target placed at a variable and gradually increasing distance from the ship. The target should be a large one, that not only perfect shots but fairly good ones will score. A bluff or steep hillside selected on shore, with an Army B target placed at a conspicuous point on this,

would answer. A rectangle sixty feet long and ten feet high could be laid off, with B target as central point, and an observer placed near by under cover to plot the shots. Shell without charge or fuze should be selected for this practice. As the crews become more expert at close range the anchorage should be shifted till a range of 800 to 1000 yards is reached. The men having obtained proficiency in this practice, the ship should get underway, and steam past the target at ranges varying from 500 to 1000 yards, at a speed of nine knots. Special attention ought to be paid to the position of the target in the field of the telescope that gives the best results, and also when using open sights how much to hold abaft the target to make a hit.

Finally, a target to be anchored off shore, and the ship to steam by, firing first at the short ranges of 500 to 1000 yards and using sub-calibre ammunition; then running by the target at ranges from 1000 to 2000 yards and firing service charges.

Competitive practice to be held at the end of the third month, under as similar conditions as possible for each man, and the men marked and rated according to their merit. The men who had become proficient turret gun pointers to be given acting appointments as gun pointers 1st or 2nd class according to merit. The gun pointer 1st class to be stationed in 10-in. turrets and above; the gun pointer 2nd class in 8-in. turrets.

The men who had become proficient as gun pointers at the auxiliary battery to be given acting appointments as gun pointers 3rd class, a few of the most proficient marksmen being given acting appointments as gun pointers 2nd class.

To hold an acting appointment as gun pointer a man must qualify as first class marksman under the conditions now laid down by the Bureau of Navigation, his score, however, to be the average of three sets of firing. After having held acting appointments two years, upon the recommendation of the commanding officer, the Department to issue a permanent appointment.

The pay of gun pointers to be as follows: 1st class, \$50 per month; 2nd class, \$40 per month; 3rd class, \$30 per month.

At the annual record practice each ship to give prizes for the highest scores in each class as follows: Gun pointers 1st class, \$100; 2nd class, \$50; 3rd class, \$25, for each four guns. Provided that no prize be given where the gun pointer averages less than 60.

Coxswains for boats to be selected, preferably, from the gun pointers, though any man possessing the qualifications for coxswain may be appointed. A man holding an appointment as coxswain to receive \$5.00 per month in addition to the pay of his former rating, as is now done for coxswains of steam launches, and the seamen acting as captain of the hold.

Gun captains in charge of 10-inch turrets and larger calibre to be rated gun captain 1st class, and those in charge of 8-inch turrets, gun captains 2nd class. As these men possess the qualifications of men now holding the rate of boatswain's mate, they would simply replace the boatswain's mates in the ship's complement so far as they extended. In many instances this organization now exists on board ship; the boatswain's mate is also the gun captain of the turret crew, and controls the same men at all times, whether at quarters or while carrying on the routine work of the ship; the routine work being carried on by divisions, the gun's crew being the unit of organization. These men to receive acting appointments in their ratings, and to be made permanent as now prescribed by Navy regulations for other acting appointments. Their pay to be that recently assigned to gun captains 1st and 2nd class by the Bureau of Navigation.

No gun captain need be stationed at the auxiliary and secondary batteries, as the duties of the men at these guns are so simple that they can be easily and quickly carried out without the need of a petty officer specially trained. There is always a gunner's mate in the division who can remedy any slight mishap to the lock, breech-plug, etc., that may occur. A gun pointer to fire the gun being the only specially trained man in the crew.

A resume of the plan suggested is the following:

(1) As the gun's crew is now the essential, and the ship is organized by divisions, replace the rating of boatswain's mate by that of gun captain.

(a) Gun captains 1st class take charge of 10-inch turrets and above.

(b) Gun captains 2nd class take charge of 8-inch turrets.

(c) Coxswains take charge of guns of 6-inch and lesser calibre.

(2) Train expert marksmen, this to be their sole requisite, and assign them to guns according to their value.

Station gun pointers 1st class at 10-inch and above.

Station gun pointers 2nd class at 8-inch.

Station gun pointers 3rd class at 6-inch and lesser.

Give coxswains \$5.00 per month in addition to the pay in their rating while so acting. Select them preferably from gun pointers where suitable men can be obtained.

(1) *The cost.*—The Department has already established the rate of pay here adopted for gun captains, and has not decided how many of them will be appointed to a ship.

If a gun captain is allowed for every gun or pair of guns in the main battery, and no reduction be made in the boatswain's mate's class, the number of petty officers would be very greatly increased. We have now a very liberal complement of petty officers. In many ships over 50 per cent of the deck force are petty officers. So, recognizing that there are going to be gun captains on board ship, this scheme would be economical.

In regard to the prizes awarded, the sum may appear large. Consider what the prizes would be on the Iowa, which would be the largest awarded: \$175 a year for men who can deliver a fatal blow to the enemy. That ship is at present authorized to pay \$250 a quarter, or \$1000 annually, for *small-arm* target practice, which of itself would be of no value in a naval engagement.

One constantly reads editorials, hears speeches and listens to arguments to show that the Navy is the means of insuring the peace and commercial prosperity of the country. This is true, and in proportion to the values insured it is very cheap. Go one step further and one finds that skill and excellence in gunnery is the insurance for the very existence of a navy; for a failure or weakness at this point would cause the disappearance of the navy in the first fleet action; its destruction by the superior fire of the enemy. Is not a liberal expenditure of ammunition and frequent target practice a cheap insurance when its value in men and material is considered?

(2) *Efficiency.*—The increased efficiency of the ship in gunnery cannot be doubted, but would the discipline and seamanship be as good?

Gun captains.—In the case of gun captains 1st and 2nd class the billets would be filled by men now holding boatswain's mate's appointments.

Coxswains.—It is held as a vital point that there must be a

skilled marksman at each gun. If among these marksmen men can be found with the qualifications required for coxswains, appoint them to that billet and pay them for their work. It is not probable that there would be any falling off in the efficiency of this class. Many of them now are unsatisfactory. They are faithful scrubbers of paint-work and of their boats, but lacking in seamanship and control of their crews. Nor is it to be expected that a man would willingly undertake the extra work and drudgery of coxswain without additional pay.

The following table gives the complement of petty officers now allowed on certain types of ships, and the number required by this scheme.

Rates Old and New.	Iowa and Indiana.		New York and Class.		Puritan and Class.		Raleigh and Class.		Marblehead and Class.	
Ch. B. M.	1		1		1		1		1	
Ch. G. C.		1		1		1		1		1
B. M., 1st c. .	4		4		2		2		1	
G. C., " . .		3		1		3		1		1
G. P., " . .		2		4		2		0		0
B. M., 2nd c. .	4		4		2		4		4	2
G. C., " . .		4		2		0		2		2
G. P., " . .		8		2		0		4		
Cox.	12		12		4		8		6	
G. C., 3rd c. .		4		12		3		7		6
Totals.	21	22	21	22	9	9	15	15	12	12

No mention has been made of a chief gun captain, but from the gun captains 1st class there could be gradually selected the most deserving men to hold the senior position of chief gun captain. He might have certain stores in his custody, similar to the present chief boatswain's mate, but this seems unnecessary. With this exception his duties would be those of the senior gun captain 1st class.

In the assignment of the complement to cruisers and gunboats it is noted that the rule first mentioned would give only 2nd class gun captains and gun pointers to the New York and her

class, and only 3rd class gun pointers to smaller cruisers and gunboats. As it is important that there should be several most excellent "all-round" men in every crew, the complement is accordingly modified.

As it is held that the training for gun pointer of a turret gun is quite different from that for a gun of the auxiliary battery, the gun pointer 2nd class sent to cruisers and gunboats should be those that had by special merit been promoted from 3rd class gun pointers, and not those holding ratings as gun pointers 2nd class at turret guns.

Target practice.—A new order of target practice has been issued, most liberal in its allowance of ammunition, requiring that target practice shall be held seven times a year, and earnestly recommending that every effort be made to develop the accuracy and rapidity of fire on board ship. If the spirit of this order be carried out the improvement in target practice will surely be most marked.

The North Atlantic squadron has recently had a very extensive series of exercises at target firing, but the results have not yet been published. One of the difficulties attending target practice is lack of suitable firing ground and target. A ship spends more time making preparations laying out targets, boats, etc., than she does in firing her battery. Regular practice grounds, with permanent targets, located as conveniently as possible, would aid greatly in carrying out the practice. Suitable ranges can be obtained in Gardner's Bay, off the Southern drill ground, and at Port Royal.

For the great gun range use the gunnery triangle as in present practice, and moor at the apex of the triangle a large sea buoy; a heavy spar buoy would be most suitable. Mount on top of this a conspicuous cage and mark it with a bell or whistle, that it may be an aid, and not a menace, to navigation. At the extremities of the base of this place a marker's buoy, to assist the ship in running over the course and to indicate the point at which she would drop her boats when they are to be used by observers.

The target to be this cage, as already stated; but when opportunity offers, place the regulation target, or the Naval Academy target, just in front of it; or better still, lay out a large target or two feet long and 10 feet high, supported at the middle

point by this buoy, and an additional buoy each side of the cage, 100 feet distant, and parallel to the base line. These two buoys would be useful in laying out a large target, and when no target was sent out from the ship a vessel could run along the base line, and with an observer in the top could get a very fair idea of the fall of the shots by having these three points on which to check the splash of the shell.

When the only preliminary to target practice consists in spreading fires and steaming out to the firing ground, it is probable that ships would be able to get out for practice much oftener than now. A vessel could then anchor on the firing ground and spend several days at sub-calibre practice, without spending half of each day getting her targets in position.

Small-arm ranges can also be established at the points named. Gardner's Bay has been in use for years, and the *Maine* is laying out a range at Port Royal. The Cape Henry beach proved very satisfactory for the practice of the Puritan, but the landing would be bad with northwesterly winds and rough weather. No doubt a range can be found at Yorktown that will prove safe, though the first range selected there was dangerous.

The small arm range should be as convenient as possible, both as regards distance and also facility for landing, etc. So that not only may the regular allowance be fired each quarter, but also rifle teams be organized on the different ships and competitive firing be held. Men belonging to these teams—and they ought to be the gun pointers mainly—might also be given practice firing at a barrel or box thrown overboard when steaming along at sea. Sub-calibre practice at sea could also be held in the same way, using the after guns and shifting the crews.

The practice on board ship with the 0.22-cal. rifle has proved quite beneficial when it has been much used in conjunction with sighting drill, especially where the drill has been made progressive. The man being exercised at sighting drill, making triangles, till he has reduced his error to a small triangle; then fire at a target with a 0.22-cal. rifle *at rest* till he makes good scores; finally give him plenty of practice without a rest, and he will make a good score on his quarterly practice.

A suitable place can be found on board ship where the target for the 0.22-cal. rifle can be set up, and crew fire, as one of the regular afternoon drills.

In order to ascertain the names of the best shots with **great** guns at present in the service, and get their average proficiency, the records of target practice for the last year have been analyzed.

Some of the results are of interest. The main battery alone is considered.

Total number of strings of shots fired, 628; total number of gun captains firing, 395, so that each gun captain fired $1\frac{1}{2}$ strings. If both moving and stationary practice were held each quarter each man would have fired 8 strings, and there would have been 78 gun captains exercised each quarter and becoming expert marksmen. The records show that nearly 400 gun captains fired and that 23 per cent failed to make any score whatever.

Only 50 men of the 400 fired at target practice more than twice during the year; only 4 men fired at the target 5 times during the year.

Nor do the scores show a good average for different quarters. A man would make 75 one quarter and 16 the next; or 120 and then 25.

The total average was 42; average for men firing 2 or more times, 44; average for men firing 3 or more times, 57.

One word in conclusion regarding an incorrect term applied to a rating that has grown up in the service, and that needs to be changed if there are to be gun pointers and gun captains. The seaman gunner is a man who has received a special training in electrical appliances and ordnance. Would not "ordnance seaman" or "seaman electrician" be a better and less confusing term, if there is need for any title to indicate that men have taken this course? The letter "O" on the records should suffice.

NOTE.—The authorities quoted are William James, J. de la Graviere and Theodore Roosevelt.

DISCUSSION.

Lieutenant A. A. ACKERMAN, U. S. N.—In the main, I agree so well with the essayist that I am inclined to criticise the modest limits which he has set to his treatment of the subject rather than anything which he has said.

On our battleships, where but one officer—including cadets—is allotted to every twenty-five men in the gun divisions, trained gun pointers are invaluable. The divisional officer's attention must frequently be drawn from the correction of ranges, etc., to the service of a particular gun, or to the combating and removal of difficulties certain to occur in many forms within the sphere of his responsibility. In the turrets a gun pointer requires peculiar training; there is a discipline of nerves and heart as well as of the eye, and without it he will, on occasion, lack the fine self-control necessary to prevent the very powers subject to his hand from causing disaster.

The introduction of the sighting telescope has practically eliminated the personal equation of the gun pointer, while the substitution of the more sensitive and easily controlled electric motors for other machines, as well as the balancing of the turrets, has made refined adjustments and pointing of heavy turrets possible. These are improvements which can be best appreciated by those who have labored amidst the groaning, lurching complications of the older types.

It is remarkable, considering the purposes for which the ships and guns were built and given us, how difficult it is to obtain frequent target practice. It must be admitted that the Department's Circular of July 22, 1897, sets forth a most wise and necessary plan for making our gun-fire truly formidable; for battles are won neither by armor nor caliber nor number of guns, alone or combined. And yet ship life is so cumbered with matters having no relation to preparation for war, that it is doubted if many ships in the navy have thus far been able to carry out the prescribed routine.

Even when the obstructions to target practice are overcome, the conditions are often such as to require haste. This is bad, for though it is difficult to explain, it is still a fact that men may drill satisfactorily every day with dummy shell and charges, and yet, when the rare occasion comes for handling the real, there is a nervous excitement which if unconsidered will surely lead to bungling and perhaps disaster.

Much has been said concerning "the man behind the gun" and his share in winning a glorious victory. He can be relied upon to do his very best, and his officers should and will do their best to render him efficient and direct his efforts to the best advantage. It seems, though, that a target practice which stops with the testing of the merits of gun pointers and the training of guns' crews is not all that is required. There is much more to be learned and practiced; much, without which the man behind the gun will become a helpless victim, and without which our officers would become mere pedants rather than trained fighters of their

ships and batteries. The conditions of target practice should as nearly as possible resemble those of actual battle,—not only for the man behind the gun, but for every officer and man, no matter what his duties. If this was done it would soon bring to a settlement many of the disputations as to the control of gun fire, determination of range, best methods of communication, etc., etc. It is the only way in which frequent and thorough trials of the ship's efficiency and condition for battle may be made.

There is just as much reason why a conning tower, if necessary at all, should be large enough for its purposes as a turret, only the service of the guns in the latter seems to be more clearly defined and insisted upon than the requirements of the occupants of the conning tower. What chance has a commanding officer to navigate his ship on soundings through the peepholes of a conning tower? It would be interesting to learn something of the views of those who have merely tried to consult a chart in the crowded space. Is it not a relic of the days of brute force that we must rely on massive indicators and three-foot wheels in an overcrowded conning tower to control the submissive giants below of steam, hydraulics and electricity? A valve or switch the size of a door-knob would do as well, and yet certain of our ships are given light draft so that they may take advantage of shoals and inshore passages to carry on the fight. Who has not heard the Central Station declared a fraud? And yet the idea is correct if it was only carried out. Now, however, we have a tiny, superheated space crowded with delicate instruments and means of communication; while the *armored tube*, instead of being at least three feet in diameter, of thin plate above the conning tower, and leading straight to the upper top—the ideal post for navigator and range observers, if not signalmen—is barely a foot in diameter, and choked with wires and tubes intended to increase the labors of the already overburdened captain. Sometimes these wires go wrong in the tube and then the amazing wonder is that they are ever got right again. The captain and his ship would be far better off if the conning tower was stripped bare, leaving the empty tube through which he could express his wishes to helmsman and other assistants in the central station below. All this could be easily arranged by making a small raid on that part of the coal supply and space which is *not* "normal" and which it is not intended should be carried in battle. It may be added that in this way our present battleships may be provided with submerged torpedo tubes without otherwise interfering with their efficiency in battle.

And now about some of the difficulties which will be met in action and which are often carefully avoided in target practice. The estimation of range through the peephole of a turret sight hood is difficult; and even if the smoke of your own and the enemy's guns obligingly removes itself, to locate the fall of your shot is more difficult, and yet the turret gun pointer must himself compensate for the variable rotation of his turret, roll of the ship, its possible change of direction, and the wind, as superimposed on the combined effect of the speeds of the two ships. It would seem that at least he should be assisted by a steady course, uniform speed, and the coaching of an outside observer.

The flat trajectories resulting from the high velocities obtained with smokeless powder and high-powered guns make moderate errors in range of comparatively little importance, and it has been proposed to avoid the difficulties of range finding by rushing in to close quarters where every shot would tell. So, the essayist tells us, was the "Macedonian" fought—until she struck. It is mortifying to admit, even for an instant, that we lack the superior trained intelligence, so long claimed for us, that will enable us to defeat a less skillful antagonist at a moderate range with the least injury to ourselves. For that matter it does not follow that we would be able to select our own point of attack; and even then, would it be wise to go inside of torpedo range?

How then is the range to be determined? No matter how obscured the horizon and water line of the enemy may be by smoke or fog, there must be frequent intervals when parts of his smokestacks or masts will be at least faintly visible, and then we would wish for a simpler, even less accurate, finder than that of Lt. Fiske, but preferably of the same type. For in battle the only base that can be absolutely relied upon is one laid down on our own ship; and if but a single arbitrary point outside is observed, the chance of continuous observations is much more certain. In default of such a method, preparations should be made in every way possible by stadimeters, Buckner's method, etc. It has been proposed to determine the range by means of sighting shots from small guns, but consider what that entails. In order to avoid confusing the fall of the trial shot with others, fragments of bursting shell, etc., the entire battery must cease firing, even the enemy must be clear of smoke; and before a successful shot is fired and the range transmitted, the relative position of the ships may have changed, again necessitating a further delay.

The aiming drills are most important; unfortunately our progress is glacier-like, and drill routines are apt to retain all the old characteristic fissures and hummocks while making new ones; they carry their past with them. And so our energies are often wasted in the effort to teach denationalized nomads to signal in English, while sub-caliber practice would be easily comprehended and more to the point.

Lieutenant WILLIAM G. CUTLER, U. S. N.,—Mr. Jackson's motto is well chosen—"Fire is everything." To it everything on board a warship should be subordinated. If on arrival within range of an enemy, we cannot hit him, all our outlay is in vain and our ships are failures. Their one object of existence is to carry their batteries within gun range of the enemy. This accomplished, and maintained through the skill of the captain and the faithful performance of duty of the engineer, the issue rests with the gun pointers. On them the captain is absolutely dependent for success, and no matter how skillfully he may handle his vessel in bringing his guns to bear to the best advantage, all is in vain unless hits can be scored.

Mr. Jackson asks the three following pertinent questions: Can we now claim superiority in gunnery over the navies of the world?

Have we reached the highest possible state of efficiency in training our men?

Have we a carefully selected and trained body of men for this purpose?

To each of these questions the American naval officer must regretfully answer—no!

In this vital matter I believe that we are sadly deficient; but I am hopeful that the present war with Spain will give us an object-lesson in the all-importance of accurate gun fire that we shall never forget, and that the future will see our officers making this feature the object of their professional lives.

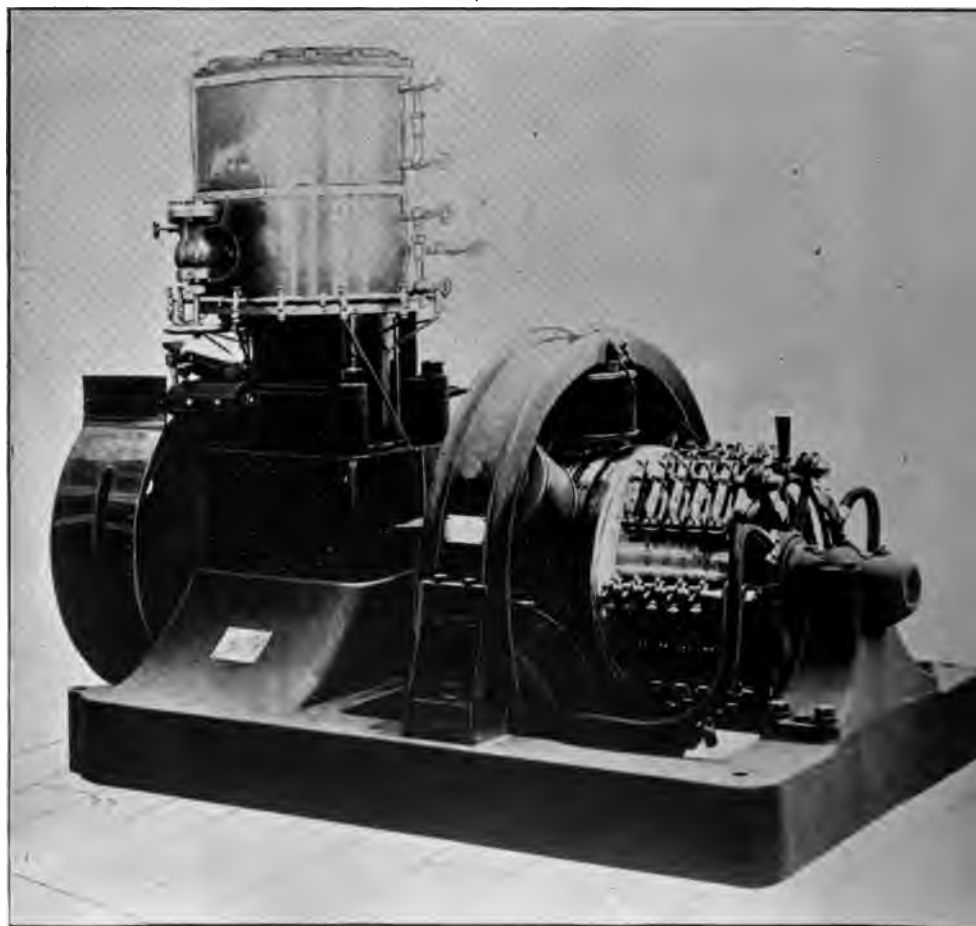
The Spanish fire both afloat and on shore has up to date (July 6th) been so excessively bad that relatively we shine by contrast. In the present war this is very satisfactory, but we are most fortunate in our adversary.

In striving for rapidity of fire let us not overlook the infinitely more important element of accuracy.

As Mr. Jackson says, the Amphitrite in her quality as gunnery training ship was a most important step. In my judgment, however, she is not the type of ship best adapted to this purpose. I believe that an absolute official line should be drawn at the calibre of gun to be fired by bluejackets. This line I would draw at the 8-in. gun. All guns of and below this calibre should be fired by bluejackets. All higher calibres by officers. The bluejackets I would put through such a course of training as Mr. Jackson suggests on board a suitable training ship. For such a training ship the Chicago would be ideal. Fitting her with every calibre of gun from 8-in. down, in the hands of enthusiastic officers she could do a great work. Her graduates, distributed throughout the service, and rated and paid according to their importance in action, would constitute a most important force in time of war. Take the Boston at Manila Bay; who was the more important in the moment of action, the machinist or yeoman, who can be gotten by the hundred, or the gun pointer of her forward 8-in. gun? *Men must be rated and paid according to their value at the guns in action.*

For the turret guns let us take the intelligent, highly educated Naval Academy graduate. Let us make more of a feature of target practice among the cadets, and put those of each class *whom nature has qualified* as natural gun pointers through a thorough practical course after graduation. The letters T. O. (Turret Officer) or their equivalent might well be placed in the Navy Register after the names of those who have qualified as such. This would be a distinction which all would covet.

Mr. Jackson's paper is most opportune, and I trust that, accompanied as it is by the object-lessons of the present war, it may do much to stimulate interest and hope in this all-important subject.



FRONTISPIECE.

50-K.W. Tandem-Compound Set for Kearsarge and Kentucky.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

DISEASES OF ELECTRICAL INSTALLATIONS IN
THE NAVY.
THEIR CAUSES AND REMEDIES.

By Lieutenant B. T. WALLING, U. S. N.

(From lectures delivered before the U. S. Naval War College.)

INTRODUCTORY.

The entire scheme and system of our electrical installations have been, from the nature of the case, progressive, and we may confidently say have shown a steady march toward improvement in details and efficiency. Ever since the introduction of electricity on board ship there has been a constantly increasing demand for this form of energy, and it is to be anticipated that much larger demands are shortly to be made upon the adoption of electrical power for turning guns as well as turrets, for operating auxiliaries, for all purposes, in short, which will minimize the present objectionable heat of long lines of steam piping, the annoying leaks of hydraulic apparatus and the excessive weights of pneumatic appliances; to this may be added that a break in a steam or hydraulic pipe could easily drive every one from the compartment.

As a simple matter of weight, the installation of any particular device is very evenly balanced between the electrical, hydraulic or steam, but when the proposed three-wire system is installed, at a saving of motor weight and 67 per cent. of copper in the leads, electricity will be far in the lead in that respect also.

Perhaps the greatest weight of argument in favor of electricity is the ready change from electrical to hand control in emergency, and the facility of maintaining and repairing the leads.

Conservatives declare that we should be slow in making such a radical change, that too many eggs are going into the same basket, that electrical science is still experimental and in its infancy, and that a stalled gun or turret in action would mean destruction.

To these we can confidently answer that the question of applicability to gun and turret use has been settled by the trolley long ago. Minute control of the power to be applied to turret or gun has been discovered in separately exciting the fields of both dynamo and motor; irregularities of turret load is a mechanical question of balance applying with equal force to any system of power.

The proof of the ready perfect control of electrical power as applied to turrets was instanced in the recent trials made on the Brooklyn at Cramp's shipyard, when the turret was successfully started and stopped *thirty-seven times in a peripheral distance of one inch in the same direction*; this result easily challenges competition; reports from trials at sea are that the turrets were handled with ease.

Our naval electrical history began in 1871 with a small Farmer's series dynamo whose armature was revolved by a hand crank and whose output did not exceed 100 to 150 watts, which then sufficed for all needs, but whose total energy would in this day be consumed by a single 32-C. P. lamp.

In 1897 the Iowa and Alabama require an output of 96,000 watts, supplied by four steam-driven compound generators of a capacity of twenty-four kilowatts each in the one case, and three of thirty-two kilowatts capacity each in the other. The Brooklyn is furnished with a total capacity of 150,000 watts; the Kearsarge and Kentucky will have 350,000 watts distributed between two double sets (100 K. W.) in the lower dynamo room and three single sets (50 K. W.) in the upper room in each ship. (See frontispiece.)

Two-thirds of this energy is for use as power, and in line with the increased and increasing demands has come the necessity for increased voltage in order to reduce wire size,* motor

* The energy of a circuit is equal to the product of the voltage (electromotive force) and current, that is,

$$\text{Energy (Work)} = CE.$$

Evidently if E is doubled we halve C , and the wire size is proportionately decreased.

dimension, weight and cost. The same demands have necessitated a change in the type of our dynamos from the "smooth body" to the "slotted core" design, by reason of superior induction and less weight and cost, and this in turn has indicated automatic circuit breakers to operate at either of the failure of the line voltage or overload. The "smooth body" armature has served us faithfully and well, but has been forced to yield to superior considerations.

The voltage selected for the three-wire system is 160 volts, thus preserving a pressure of 80 volts at the lamps. It is often asked why we do not use commercial voltage at 125 or 250 volts and thus avoid the extra expense of special machines, lamps and supplies, for which we are paying from ten to twenty per cent. in addition. The answer advanced is that, while our insulation can easily stand the higher voltage, we are insuring good insulation at the lesser voltage and avoiding the exorbitant losses in search-light rheostats; the commercial practice of placing two search-lights in series has some mechanical difficulties in ship installation.

The application of electricity to naval purposes is now so generally understood that it requires no mention here; the results of those uses as obtained from ship discussion, quarterly returns, official complaint and the large bills for repairs and supplies are the factors with which we are concerned, and which have occupied the attention and close study of those directly in charge of the branch, in order that the faults and remedies could be certainly ascertained and specifications made more stringent to avoid recurrence.

Notwithstanding all the discussion, complaint and repair, it has only been within the past two years that any *range* of information could be obtained upon which to base new specifications which would ensure what we want and are entitled to have.

This has been chiefly due to the fact that the information at hand has been repetitions of facts already canvassed, particularly as regarded increased or increasing coal consumption in the A and B types of the General Electric engines, long since known and admitted as poor types, inefficient and wasteful, if indeed they can, after reasonable service, be pushed to their rated outputs; again, a large mass of suggestion for improvement has been predicated upon experience and device as associated with

the single plant at hand without recourse to changes that have been made or are making elsewhere.

The visits of officers, for acquirement of new information, to the electrical store-rooms and workshops of a well-equipped Navy Yard, where inspection, test, assembling and manufacture of electrical material, appliances and supplies are continually in progress, are rarer than the eclipses of the sun or moon. A navigator or his assistant occasionally appears to look up delayed articles of an approved requisition; a dynamo man strolls in now and then for permission to "look about and pick up a few points," but his thirst for knowledge is quite apt to terminate abruptly at a stray tool whose isolation and position he has probably located previously and which may "come in handy some time." The ship which is building at the dock, with all the newest wrinkles and points, is passed by and forgotten.

So it has resulted that, until a year ago, when opportunity was afforded to repair and overhaul the installations of twelve ships representing almost all the types and classes in the service, information on the general subject has been too meagre to form a good basis for specifications for future work and material, especially regarding the ever vexed and much abused subject of interior communications.

New specifications have been issued this year, which to this date, September 1, 1897, have stood the test of criticism and revision on all cases presented, and are made an appendix to this article.

The general aim has been:

To restrict contract ships to the limits of good workmanship in original installation;

To reduce experimental work and devices to a minimum, *i. e.*, by establishing a system of standards both as a guide to requisition and to ensure uniformity of details and strict interchangeability in our ships.

It is understood that any system of standards is to meet severe opposition from many quarters, but much time and study have been devoted to these electrical standards on the lines of continuity of service, sound electrical principles and simplicity, and needed changes can be made as progress demands. We at least secure for the present that our new battleships shall be installed in the best manner to date. Even then we are trammelled in

obtaining the best, as far as some supplies are concerned, by the two stumbling-blocks, "barring competition" and "proprietary article," which by law prevent us from obtaining in open market what we know to be the desideratum. A familiar example of barring competition is that of lubricating oil, which can be mixed and juggled to pass any devised or devisable set of specifications ever issued.

Good special oils can be obtained by purchase from especial makers and the grade be satisfactorily maintained. Bids must be issued under the law; monopolies crush out the smaller dealers.

Any oil costing less than thirty-five to forty cents per gallon is, for dynamo use, an object of distrust.

"Proprietary article" is a favorite recourse with contractors when "barring competition" will not fit or fails of success.

Our engine indicators have had an especial experience under this head. Whatever may be the niceties and novelties of device in these instruments, faith in their operation must be pinned entirely to the integrity of the spring. The Ashcroft-Tabor indicator, so long in successful use in the service and elsewhere, is fitted with a "duplex" spring—two spirals coiled in opposite directions with containing caps—which is patented, but whose longevity, and therefore integrity of action, is far superior to any device in the market; all other like instruments depend on a single spring, whose operation becomes in a short time dubious and unreliable. Spare springs are provided if one only could tell just when the old should be replaced; with the Tabor instrument there can be little doubt on the subject.

Two instances of the results of the above examples:

Ten thousand gallons of mineral oil (nearly 200 barrels) were delivered into store at the New York Navy Yard in the fall of 1896; were inspected later on, having time to settle meanwhile, and passed into store; the bid was seventeen cents per gallon. The first issued was used on the journals of the 8-inch shaft of the 250 H. P. engine driving the electric plant of the Navy Yard, and at a critical time when the plant was supplying light for getting up steam on a ship about to be undocked. So excessive was the amount of grit and dirt in the oil that the plant could be kept going only by use of a liberal stream of water from a hydrant until better oil could be obtained; filtering produced but

little effect; the oil was also very deficient in "body," a matter that no amount of filtering can reach.

Until recently the Tabor indicator has been our regular supply, but some makers of single spring instruments have supplied a lot by underbidding and successfully over-riding rejection by reason of the patent held on the duplex spring.

These cases are growing fewer in number since the standards have been adopted; contractors are not prone to face the expense of delivery, removal and redelivery where it is expressly stated on the face of the schedule that samples are to be seen on application.

The unsettled questions of to-day, fortunately few in number, are rather those of mechanical details than electrical principles. Good design, efficient insulation, sound connections and thorough water-tightness mark the not uncertain road to security and success in original installation, of which design alone will be progressive and variable. Continuity of service and confidence on board ship rest upon intelligent operation and mechanical aptitude.

Continuity of service and endurance of our plants is now suffering from lack of interest, and apathy on the part of officers. The pioneers of our naval electric installations, and who are perhaps, popularly supposed to be still at the head of affairs, have been called away by the exactions of rank or duty, and but little new blood is being infused.

It is difficult even to obtain inspectors for the various works of contractors, or, at least, difficult to obtain at those points the services of an officer who feels himself in a position to cope with the subject.

The navigator on board ship is charged by regulation with the responsibility of the whole installation; his duties in the other branches of his department, coupled with correspondence when off the bridge, leave him but scant time for the electric plant in its numerous details; his duty ashore has often been in connection with other branches of the service, which gave him but little time for anything more than a very general interest in electricity or its details in ship construction. Placed on board ship, in charge of a large and expensive plant, he must rely on the assistance of the Navy Yard force or be relegated to a dependence on his head dynamo man, which is usually leaning on a broken reed.

Our installations have been brought to a high state of efficiency through the research and stiff-necked insistence of those who worked out its early details; what we need most now are care and skill in manipulation.

We have the right to point with pride to the achievements of our early pioneers, who came into the field to face the difficulties of a proposition entirely in the air, environed by a fast changing and improving science, without so much as a satisfactory generating set for ship use, with ill-matured appliances and poorer wire; to the fact that it was a naval officer who first suggested direct connection of dynamos to their engines, now so popular commercially, and imperative on board ship; that another officer designed and inspired the first successful fire-proof installation in this country, that of the Broadway Theatre in New York; and it is to be regretted that their sort is seemingly to disappear from the field unless some measure is taken to supply their place.

SHORT-STROKE ENGINES AND WATER CONSUMPTION.

The final summation of all energy developed by the generating sets, both useful and wasted, is the consumption of water, of which the practical evidence is the coal account and expenditure.

The wasted energy can be properly divided into two heads:

1. That which is common and necessary to all engines, somewhat increased by wear and tear, but still approximating a fixed maximum.
2. That which is due to losses from the faults of which we treat.

Losses comprised under the second head are those which are remediable and should be eliminated; those comprised under the first head are remediable only in design, and form the basis of competition amongst engine-builders, particularly amongst those builders who are interested in the modern short-stroke types.

Defined as those used for driving machinery which runs at a high speed of rotation, such as dynamos, centrifugal pumps and the like, short-stroke engines have of late been the subject of much rivalry amongst designers, both as to the merits of single-acting as opposed to double-acting engines and simple versus compound.

The questions involved are not those of high-speed engines alone; the difference exists in the fact that "high-speed engines" is the title of a class as opposed to "low-speed engines," and includes engines used for torpedo boats and locomotives in addition to the short-stroke types; the last-named types, having a stroke of from but five to six inches, are alone those with which we are concerned.

The most concisely stated review of the short-stroke types is contained in a paper read in January, 1897, by Mr. J. S. Raworth, a well known English builder and designer. This paper presents the very remarkable statement that, from observations of experiments with over 100,000 I. H. P., it is established that modern short-stroke engines are at least quite equal to long-stroke engines in mechanical efficiency; as it cannot be accounted for on a simple theory of constant thrust, ready explanation is to be found in the better lubrication of the working parts, and in the better distribution of stress by reason of the increased inertia due to the high rate of reciprocation of the pistons.

The necessary waste steam consumption in an engine is usually distributed amongst four well established sources of loss:

1. Clearance.
2. Port friction.
3. Condensation.
4. Leakage.

Clearance must be provided for easing the racking strain of fast piston reversals, and must necessarily increase in percentage as the number of reversals is increased.

The *volume* of clearance in any given pattern of engine varies with the area of the piston and is nearly independent of the length of stroke; but when expressed as a *percentage of the volume of the cylinder* it will obviously increase as the stroke diminishes—the usual 3 per cent. on a five-foot stroke would become 36 per cent. if the stroke were reduced to 5 inches.

This clearance loss is severe in all short-stroke engines and is practically constant for the type.

Port friction may be defined as a sort of added clearance, the volume necessary for the ports, combined with a choking of the steam in its passage to the cylinder. This loss is nearly a minimum in our dynamo engines, as the ports are fairly large and straight.

Condensation is found in all reciprocating engines, and is principally due to the fact that the wall of the cylinder is alternately exposed to high and low temperatures. It is stated that the temperature difference approximates 180° F., about that between boiling water and ice.

In a compound engine the temperature difference is approximately halved in each cylinder, with necessarily great reduction in condensation.

It is obvious that the rate of cooling will vary with the time of exposure, that is, it will be less with increased speed, and in general it is established that there will be a saving of nearly one-half by doubling the speed. This is only an approximation, however, as part of the condensation is due to the radiation of the atmosphere, and another part to the direct conduction of heat from the cylinders to the bedplate and working parts of the engine. The Case engine used with some smaller types of machines is a familiar example of this conduction. In almost every test the water and oil will boil out from the well in the base, at first slowly, and then violently, as the temperature rises from the heated crank. An air tube has lately been suggested as a remedy for the difficulty, but thus far has had no practical trial.

This Case engine will generally slow down of itself as the temperature rises, then, as the temperature falls, it will work back slowly to the original speed, causing a very objectionable fluctuating voltage in the circuits.

Steam jacketing is naturally suggested as a remedy for condensation, but in short-stroke engines, even when compound, the gain in the cylinder is so evenly balanced by the large loss in the jacket as to render the expedient expensive and unnecessary.

The fourth source of loss, leakage, is one with which we are especially concerned, as it is an inherent vice of piston valves—our usual type—and is not only much increased by wear, causing back pressure and increased loss from that source, but it appears in the cylinders as well, as the pistons wear, destroying pressure, which means more coal.

Valve leakage will be readily understood when it is stated that from this loss alone it has been found that engines, apparently in good order, even when standing still, took as high as 30 to 40 per cent. more than their normal requirement of steam;

and, though the automatic governor handled them well as new engines and when running without load, they ran practically independent of the governor under the new conditions until loaded to about 20 per cent.

From 15 to 20 per cent. of the steam delivered at the throttle is the plain statement of the summation of these four losses in a new dynamo engine that has been subjected only to those preliminary trials necessary to put it in proper order for turning over to a commanding officer, and the statement is believed to be conservative. It does not include water in the cylinder, which is practically indeterminate.

What occurs in service is best illustrated by the case of the *Marblehead*; in that ship the coal expenditure for auxiliaries increased over one hundred per cent. above the amount necessary at first commission. This is unquestionably a serious matter, especially when, on protracted voyages, economy in the visible coal supply must be rigorously observed and enforced.

The dynamo engines do not use all the coal charged up to auxiliaries, but from the nature of their use they are responsible for a large proportion of the expenditure, certainly for a lion's share of the increase.

Several commanding officers have recently inaugurated experiments for the purpose of ascertaining this increase. Usually such results are in error for the simple reason that there is rarely an opportunity on board ship when the dynamos can be run to the exclusion of all other auxiliaries. The following means of obtaining a fair approximation are suggested:

The best time for the test is probably between six and eight o'clock in the evening, as steam for the galley, flushing pumps and blowers can be best spared at this time.

Shut down everything using steam except the dynamo under test.

Break the joint of a pipe leading to the feed tank, or better, the auxiliary condenser if practicable.

Provide a steep-tub for catching and measuring the water, and carefully measure into it enough water to fill it to within two inches of the top; this will be about 30 gallons, 250 pounds, for the ordinary tub that is used about the galley. Mark the level on the inner side of the tub. It is merely necessary to count the number of times the tub is filled, emptying each time directly

into the bilge and catching the water for the moment with a bucket.

The dynamo should be run with at least 75 per cent. of full load, as dynamos are never efficient or economical at loads below that percentage.

The voltage and load should be kept as steady as possible, and the voltmeter and ammeter should be read every fifteen minutes in order to obtain a good mean.

An hour and a half is sufficient time for the test, but it is better to run for two hours if it can be done.

A set of cards should be taken each hour.

The ratio of the output, as determined by the product of the mean current and voltage, to the horse-power obtained from the cards is the over-all efficiency for that load; the water consumption per K. W.-hour or per I. H. P.-hour is readily obtained from the quantity of water used.

This may appear, at first blush, a rather rough method, but in reality the results will be found to be quite satisfactory.

Data of this kind are very much wanted, especially in engines where the coal consumption has increased.

On acceptance tests the water is measured directly at the surface condenser by draining into a barrel which rests on a platform scale and can be emptied by a stop-cock. The water is weighed every fifteen minutes, the instruments being recorded every half-hour throughout the four-hour-heat run.

What the water consumption of our engines should be has never been determined, that is, no specification is made which covers the important point; at the same time if a specification were made the engine-builder would be quite sure to step in and say that it was too stiff and unreasonable.

For 24-K. W. types and upward it would seem that a new engine should not require more than 35 pounds of water per K. W.-hour if compound, or 42 pounds if simple.*

A 50-K. W. set has recently been built on the designs for the single sets of the Kearsarge and Kentucky which consumed, on acceptance test, but 30 pounds per K. W.-hour, confirming the liberality of the above figures.

* A kilowatt is a thousand watts; a horse-power is 746 watts, practically 750 watts. A kilowatt is therefore equal to $1\frac{1}{3}$ horse-power, and a horse-power to three-fourths of a kilowatt.

There seem to be no data as to the water consumption of the numerous engines of the General Electric Company's manufacture which we have, but in the A, B, and those of the C types which have no packing rings, the consumption must originally have been between 50 and 60 pounds per I. H. P.-hour. The two A type machines in the Maine are now using over a hundred pounds per I. H. P.-hour, which, of course, is very excessive.

The remedy for large water consumption is more closely fitting valves and, in engines not so fitted, packing rings on the piston; a number of engines have been repaired in this way aboard our ships and the coal expenditure materially decreased.

Throttling down, reducing pressure when running under light loads, particularly at night, is a common practice of dynamo men which cannot be too strongly condemned. They do it usually under the impression that they are saving steam and also because the governor is inclined to be a little noisy at small loads if the throttle is wide open. The valve fit is what is known as an expansion fit, the best results being secured at the steam temperature of the standard pressure of the design, viz., 100 pounds for compound engines and 80 for simple engines; throttling down, reducing pressure and therefore temperature, must therefore promote leakage past the valve.

At any load the governor will regulate the expenditure of steam more efficiently than can any dynamo man at the throttle, and it should be the invariable practice to run at the prescribed number of revolutions as shown on the name-plate * with the throttle wide open and let the governor take care of the steam, as it was designed to do.

The theoretical governor for best economy is one that cuts off from full to half load and throttles from half load to no load; thus far all governors constructed on the principle have been mechanical failures.

Reduced steam pressure is another fruitful source of waste

* Name plates usually show the name of the manufacturer and the type or form together with the rated speed and capacity of the machine, thus:

M. P.—4—50—400,

which signifies—Multipolar, four poles, 50 K. W., four hundred revolutions per minute. A plate is attached to the bedplate of both dynamo and engine and should show the frame number of the dynamo and the number of the engine for convenience in ordering spare parts. The armature number is generally stamped on the end of the sleeve or shaft.

steam on board ship. Engines are run at pressures as low as 35 pounds, for the reason that no higher pressure is to be had; neither the engine nor governor was ever designed to work economically at any such pressure, nor will they. If no higher pressure than 50 pounds for a simple engine, or 65 pounds for a compound can be had, and coal economy is desirable, it is better to shut down the plant and burn oil; it may not prove an economy in so far as the ledger account is concerned, but it is the certain way to save coal. The remarks made on throttling down apply here with equal force.

A corollary to reduced pressure and throttling down is throttle governing. When the governor has quit, so to speak, as our very troublesome one on the General Electric types A and B generally does within a short time, dismantling the governor or blocking it, thus reducing the system to a mere fly-wheel arrangement, is the only resource, and throttle governing is made compulsory. It is necessarily, though unavoidably, wasteful of steam, and is attended with some danger to the engine if care is not taken to raise the carrying capacity of the dynamo main fuse at the switchboard. Take, for example, the case of a 32-K.W. machine running along with a load of 350 amperes, the throttle practically wide open, governor dismantled or blocked, and governing by the throttle. Presume now a sudden overload to push back to the switchboard a heavy momentary current which we will assume to be 600 amperes; the main fuse would immediately blow, as its carrying capacity is only 400 amperes, and the armature would be safe. Not so the engine; all load has been suddenly removed from it when under full head of steam and no automatic means of shutting off steam is at hand; it is apparent that unless the dynamo man gets quickly to the throttle the engine can do itself any damage up to racking to pieces.

If that dynamo main fuse had had a capacity of, say 800 amperes instead of 400, and the same large current had rushed through, the overload would have slowed the engine and the dynamo armature would have had to stand the brunt. This state of affairs is rather undesirable, but as our dynamos can be relied on to carry, for a brief time, an excess of at least 50 per cent. above their rated capacity, overloading the dynamo is far the lesser evil as compared with wrecking the engine.

The matter is not fanciful or exaggerated; it has occurred in the service, resulting in that instance in a broken connecting rod, attributed, however, to water in the cylinder. Water in the cylinder is a ready explanation of most of these accidents to small engines, for the reason that the cylinder heads are very strong in comparison with those of larger types, and will not usually blow out; in the case of the Katahdin the four stanchions which support the cylinders carried away, tumbling the engine on the deck, but the cylinder heads held.

In the case of the connecting rod the presence of water was not well established, while the evidence showed that the engine suddenly raced away and broke the rod before the attendant could get to the throttle; the main fuse of the dynamo was found to have blown.

In one ship in the service, running with blocked governor and throttle-governed, the head dynamo man has *reduced* the carrying capacity of his main fuse; this means that he has weakened the safeguard to his engine and brought the verge of disaster a little closer home.

THE USE OF OIL IN CYLINDERS.

The majority of the difficulties with our generating sets, of the troubles at least which occasion most frequent remark, complaint and repair, reside in the engines; the dynamos usually give little annoyance.

These difficulties are met with mostly in the A and B types of the General Electric engines, which types constitute over 50 per cent. of all that have been installed, and are admittedly inefficient and uneconomical after short service use; that they are so is the silent protest against the prohibition of the use of oil in cylinders.

Immediately after this prohibition was promulgated, other makers of short-stroke engines, Armington and Sims, Ball and Wood, and Westinghouse, for example, simply refused to build engines under such a restriction, withdrew from our market and declined to make any bids on the specifications.

The General Electric Company then stepped in and undertook to supply the engines as specified, and after a long series of efforts and designs, of which their A, B, and C types are familiar service examples, they finally put packing rings on an engine supplied to the Massachusetts in January, 1897, and used a little

oil. The company has now practically retreated from the field, as the experimental set representing the design intended for the Kearsarge and Kentucky has a lubricator on the steam pipe.

The consensus of opinion amongst builders of the short-stroke types seems to be that cylinder oil is a necessity to endurance and economy, and it is the fact that in but one ship in our service, and this after supplying packing rings to the piston, has the water surface proved satisfactory; in that ship the plant was under the supervision of an officer high up in the electrical councils of the Navy, which is "another story." The saving in coal from the use of rings in this case was over 30 per cent.

It cannot be gainsaid that oil in the exhaust steam exercises a very pernicious effect upon condensers and main boilers, and that the ground against its use is well taken. On the other hand, it is quite certain that the effort to run engines without any lubricant in the steam has been very costly for us in coal, due to bad governing and to the large increase in water consumption from abnormal wear of cylinders, pistons, and valves; this wear, as before stated, has for its remedy packing rings on the piston and closer fit, both demanding, practically, oil in the steam, though the statement is disputed.

Those who protest against the use of oil, comprising about all who are responsible for boilers, usually point out that main engines, such as those of the New York and Cushing, are continually run without any cylinder lubricant; but it is also the fact that the cylinders of main engines, when at rest, are coated with a heavy oil or vaseline for the purpose of preventing the pistons from "freezing" (rusting) to the cylinder walls, and it may be an open question whether an oil-coating, once formed, will permit the formation of a water surface thereafter. In the case of the Cushing it is very difficult to get into the cylinders at all, and for that reason her pistons must usually work on the lubrication of the water surface. In neither case have we an example of a short-stroke engine, which fact is entitled to its due weight.

The solution of the matter for both sides seems to rest in the use of an appliance on the exhaust which will extract the oil from the steam on its way to the condenser. Several designs of this nature, variously styled steam-washer, grease extractor and oil eliminator, are to be had in the market, showing efficiencies as high as 75 to 80 per cent.; assuming the proper amount

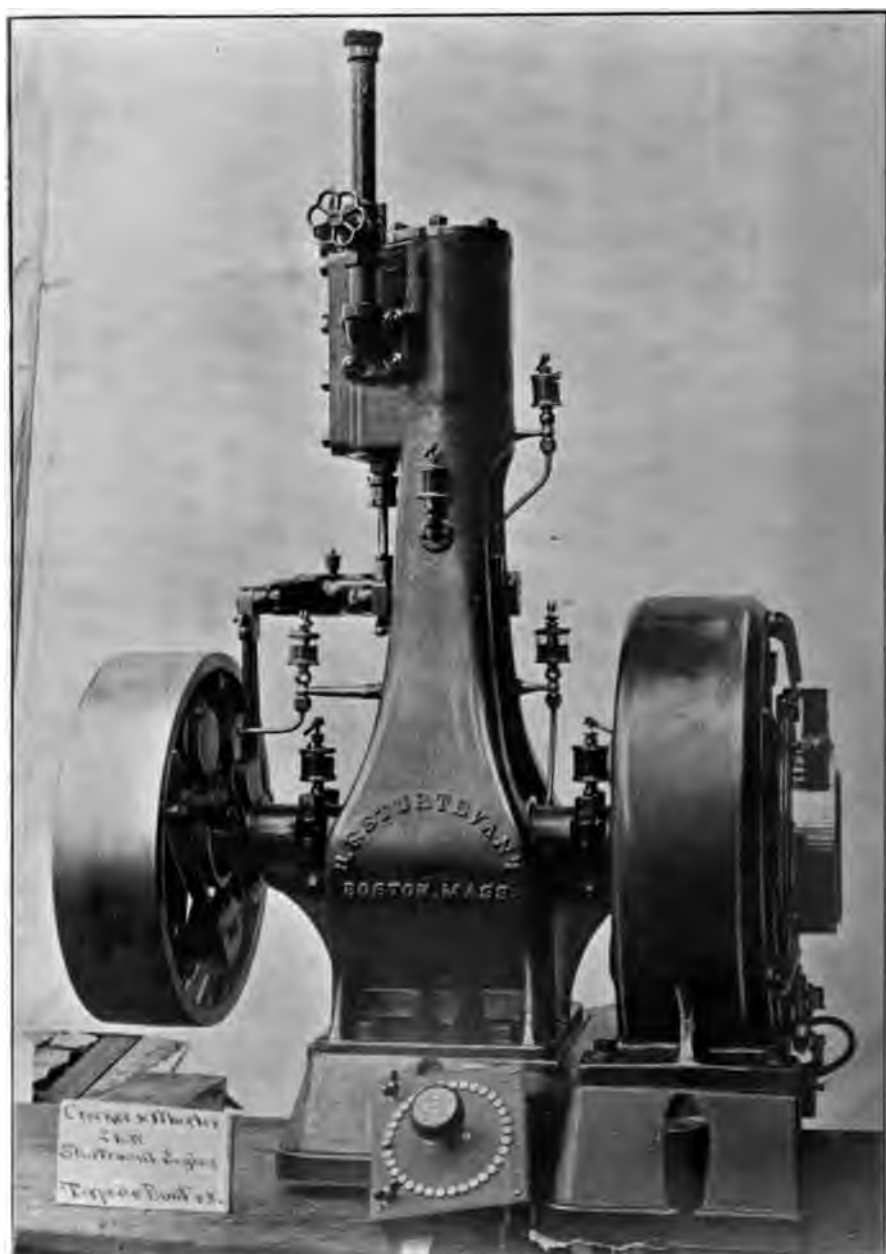


FIG. 1.

2-K.W. Set for Torpedo-Boat Rowan.

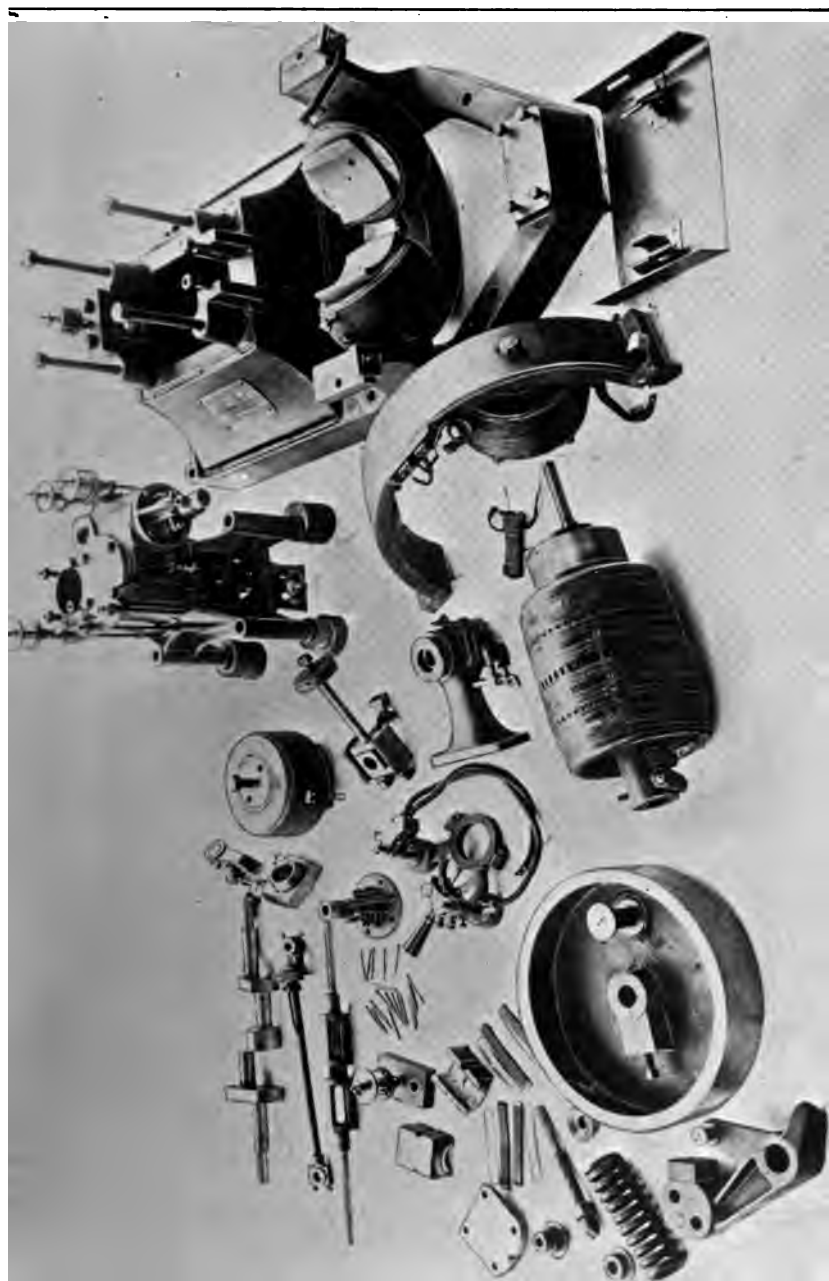


FIG. 2.

2-K.W. Boat Sets.

of oil to be used at ten ounces per diem, this appliance would undoubtedly protect the boilers and condensers sufficiently to remove all objection.

Unfortunately all types of the many designs in successful use commercially are for atmospheric exhaust only, and thus far not a single one has been found that can be recommended for a condensing engine.

Experiments in that direction are making.

ENGINES.

The discussion of engine faults resolves itself mainly into treating of those of the General Electric types, as well for the reason that they constitute so large a majority of all we have in use, as that it is in those types that the faults have been chiefly observed, whether due to the particular designs themselves or to inherent characteristics of engines in general; and it is but just to remark parenthetically, that on original test no engines could operate more satisfactorily or accord more closely with the rigid letter of the specifications, except, perhaps, in the matter of the noise and want of balance of those having 90° cranks.

We can dismiss from the consideration the types of other makers with a brief remark for each.

A few generating sets with especial types of generators have been introduced from time to time for experiment; they have generally been small sets of 2 and 4 K. W. capacity, in which neither efficiency nor economy was sought or expected. Of these the Sturdevant engine (Crocker-Wheeler generator) showed the remarkable regulation of one per cent. from full to no load, five revolutions at a rated speed of five hundred. The set is shown in Fig. 1; it is installed in Torpedo boat No. 8 (Rowan). The General Electric Company have supplied a very pretty little engine for the boat sets, having a rotary valve. The set is shown in Fig. 2. Its operation is absolutely noiseless. The engines of both these sets are quite heavy for the capacity, and develop an over-all efficiency of between 50 and 60 per cent., as against 83 to 86 per cent. in larger machines.

The Ericsson set, with Case engines, is shown in Fig. 3.

The remaining large engines are mainly those of Bellis, Arm-



FIG. 3.

2-K.W. Set for Ericsson, with Case Engine.

ington & Sims, and the Union Iron Works; all use a lubricant in the cylinder.

The Bellis-Siemens sets (Fig. 4) were bought in England. The engine is of good, strong construction and works well. It has the disadvantage that the governor action is that of throttling, which occasions poorer regulation and economy than we have a right to expect now-a-days. It is possible to adjust the governor for any steady load, but the adjustment will not answer for any other load. If left to govern according to the design, the speed becomes variable at fluctuating loads, resulting in irregular voltage.

The series field of Siemens generators is wound outside of one shunt coil only, causing a difference of intensity at the periphery of the armature, making it a little one-sided, so to speak. In addition the dynamo has the large stray field common to all bipolar constructions. The sets, however, give little trouble and are for that reason quite popular on the ships in which they have been installed.

The Armington & Sims and Union Iron Works types have proven very satisfactory after extended use; the latter are generally cross-compound, even in sets of four kilowatts.

The general appearance of the A and B types of the General Electric Company's manufacture is shown in Fig. 5. In reality the two types are practically one, as the only important difference lies in the construction of the engine bearing nearest the dynamo. In the A type this bearing consists of two bearings, one of which is boxed off from the engine frame; in the B type the box bearing is omitted, the other being made a little longer; this arrangement adds materially to convenience in handling the shaft.

The engines are simple and designed to work at 80 pounds of steam.

The valve chests are located between the cylinders, and directly under them on the shaft is the governor carrying the eccentrics for the valve stems. The crank shaft and armature shaft are in one without coupling, the dynamo end being provided with ring oilers of the type shown in Fig. 6. The cranks are at an angle of 90° , causing the want of balance and noise predicted for them in a previous article of the Institute.

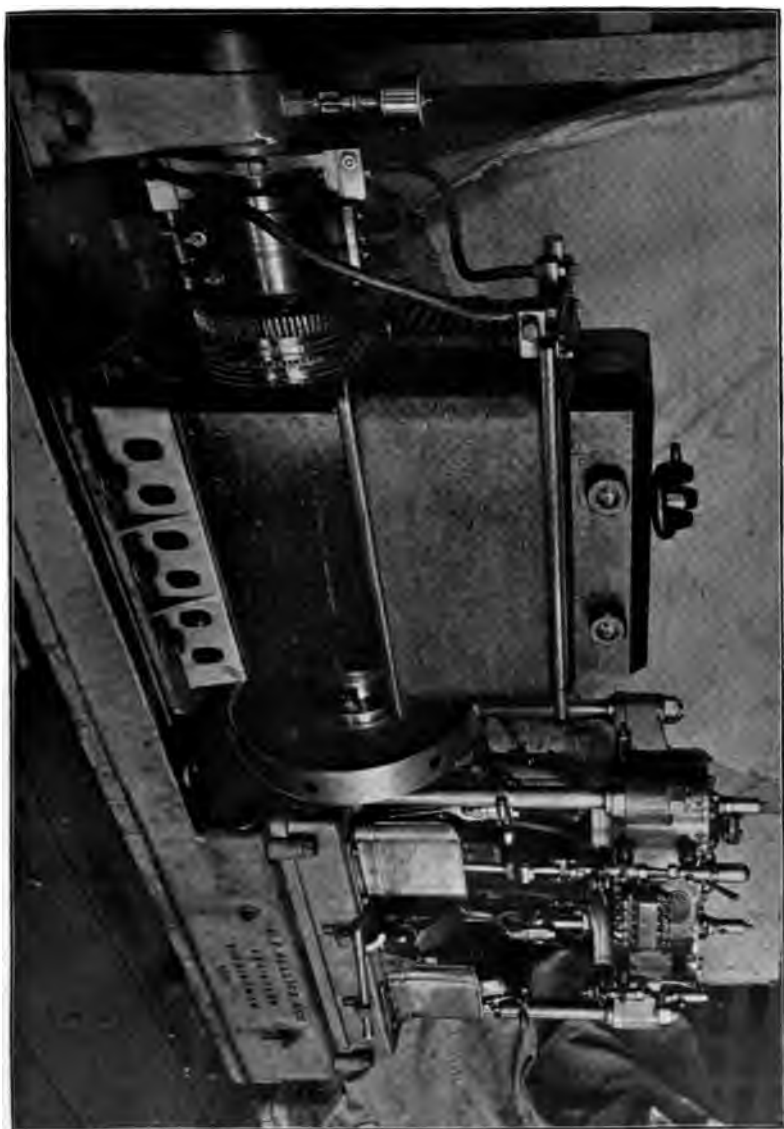


FIG. 4.

Siemens-Bell 32-K.W. Set.

CYLINDERS.

The chief fault has been abnormal erosion and wear, of which the Marblehead, and to a lesser degree the Columbia, have furnished the best examples.

When the bonnets were removed it was expected that the wear would be practically equal all around, but there was found, in addition to a deep scoring, an oval wear, in the plane perpen-

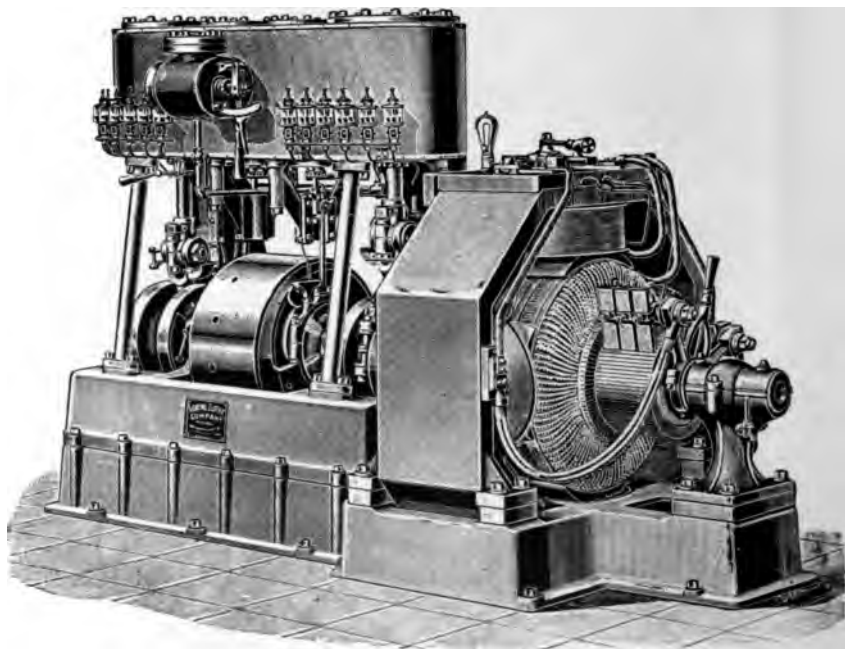


FIG. 5.

Electric Set; Engine, Type A

dicular to that of the shaft; the edges of the piston were worn and the rim rounded off. The leakage of steam from the steam side to the exhaust side of the piston must have been very great.

This oval wear is unquestionably caused by the cocking of the piston. The cross-head is supposed to prevent this, and it is evident that there must have been a lateral play of the cross-head in the guides, which had not been taken up. In a C type machine, lately supplied, the pistons are centered by a tail rod;

K.W.	SLEEVES TYPES A, B, C.		
	Mark	Length	Bore
32		10 $\frac{3}{4}$ "	2 $\frac{3}{8}$ "
24		10 $\frac{3}{4}$ "	2 $\frac{3}{8}$ "
16		8 $\frac{3}{4}$ "	2 $\frac{3}{8}$ "
8		8"	1 $\frac{7}{8}$ "

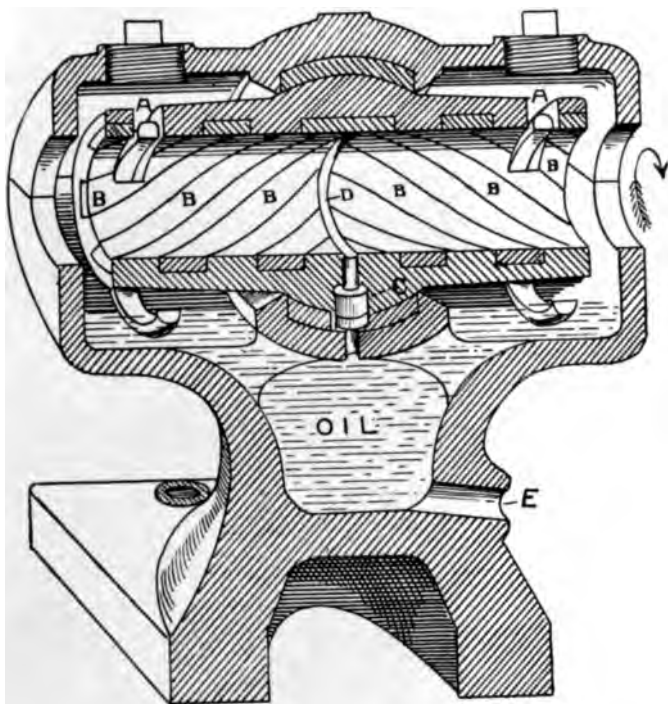


FIG. 6.

Self-Oiling Bearing for Generating Sets.

The bearing itself is a sleeve held in the pillow block by a ball and socket joint, and hence is self-lining. The lower part of the pillow block forms a reservoir for oil. Two slots in the upper part of the sleeve are cut transversely, on near each end, exposing the upper surface of shaft at these places. Two bronze rings (*A A*) dipping below the surface of the oil in the reservoir, rest on the exposed parts of the shaft and are driven by it. The sleeve is cast iron. On the bearing surface of the sleeve, spiral grooves (*BB*) are cast, running right-handed from one and left-handed from the other end. These grooves are filled with babbitt metal, the bearing surface thus consisting of spiral bands, alternately babbitt and cast iron. A groove (*D*) is cut round the middle of the sleeve, where the spirals meet; it communicates with the oil reservoir by holes (*C*) in the ball of the sleeve and the socket bearing of the pillow block. The oil may be drawn off from the reservoir by a pet cock screwed into the hole (*E*) in the pillow block.

When a machine with bearings of this construction is running, the motion of the shaft keeps the rings (*A A*) continually revolving and carrying oil from the reservoir to the ends of the bearing. The oil delivered at the ends of the bearing is swept towards the middle of the sleeve by the action of the revolving shaft on the spirals. At the middle of the sleeve the oil is collected by the groove (*D*) and returns by the hole (*C*) to the bottom of the reservoir where it has time to settle and cool.

Depending only on the motion of the shaft, the oiling action of this bearing is entirely automatic. Starting the machine starts a flow of oil through the bearing which is continually maintained whilst the machine is running and stops the moment the machine is stopped.

An arrow is cast on the upper surface of the sleeve, and the latter must be set so that the upper surface of the shaft runs in the direction the arrow points.

It is recommended that these bearings should be examined once a week, although the oil does not need to be renewed as often as that.



FIG. 7.
16-K.W. Piston, with and without Packing Rings.

but it is doubtful whether in small engines the device is worthy of the trouble or expense.

The steam leakage around the piston is best remedied by packing rings. Fig. 7 shows a 16 K. W. piston so fitted, and also the original design without rings. A worn cylinder requires reboring.

The section of the packing ring shown in the figure is square.

Rings of this section are prone to break or to cause a clicking noise from want of sufficient bearing surface in the grooves. The later and better practice is to make the ring width from two to four times the thickness, deepen the groove accordingly, and divide the ring into two or three pieces for convenience in entering.

These wider rings are designed to take against elliptical springs, held to the bottom of the grooves by set-screws.



FIG. 8.

Piston Valve.

VALVES.

Fig. 8 shows the usual type of piston valve in use. It has ordinarily been made of bronze, presumably for the purpose of lessening friction and wear. A number of instances of wear in these valves rather demonstrates that the idea is not well borne out. Cast iron is now used, as it not only insures a good expansion fit, from similarity of expansion with the material of the seat, but answers all the practical demands of wear.

Wear of valves and lack in tightness of fit are indicated by the balloting of the valves against the side of the chest, and always means increased leakage. In some large engines packing rings have been fitted; this entails a danger of catching at the ports, best obviated by bridging; in small engines, however, the bridges

would probably need to be diagonal, an annoyance and expense in casting.

Valves often show anomalies even for the same type and size of machine; in some engines the valves are not interchangeable, this is in direct violation of the specifications; in others the lap or lead will be quite different, a troublesome matter in valve setting, which is at best an undertaking of no mean proportions with some of our engines.

The available method is to lengthen or shorten the travel by means of the nuts on the valve stem. In setting valves on the Amphitrite it was found that only a quarter of a turn of the nut, on a thread pitched eleven to the inch, would entirely change the character of the card. What the valve really needed was a little more lead, not attainable for the reason that the eccentric is bolted solidly to the governor casting and cannot be given angular advance. The best that could be done, pending the construction of a new eccentric, was to adjust the work between the cylinders as evenly as possible; when completed the cards showed that one of the cylinders was doing four-fifths of the work, instead of one-half as it should.

The large amount of breakage of valve stems is a question of valve guides and governors, which will be touched upon later on. Fig. 9 shows a section of the valve used with the 32-K. W., smooth body types.

PISTON RODS.

These give little trouble; they are very strong comparatively, and escape the effects of water in the cylinder. But a single case has been observed arising at this point, and it was really a matter of the stuffing box; the gland had not been properly entered on the thread, canted instead of catching fair, resulting in binding the rod and stopping the engine.

CROSSHEADS.

It is always at the crosshead that the first trouble with a new engine develops. Fig. 10 shows two views of the pattern used on the large engines of our sets. The connecting rod is fitted to it with the ordinary strap, gib and key. The first fault appears as a rattle, then a decided knock at the pin, with consid-

erable lost motion. It would seem almost unnecessary to point out that the set should be stopped at the earliest possible moment after any rattling or knocking develops and the key set up, yet ships come to the Yard hammering at the crosshead until it would almost seem that the system was to fall to pieces, and in almost every case from sheer carelessness and neglect.

Now, lost motion in any of the working parts, whether it be crosshead, link, governor weight, or bearing, always exists at the expense of speed, slowing the engine as the load is increased, which means low voltage, or racing as the load is decreased, which sends the voltage up.

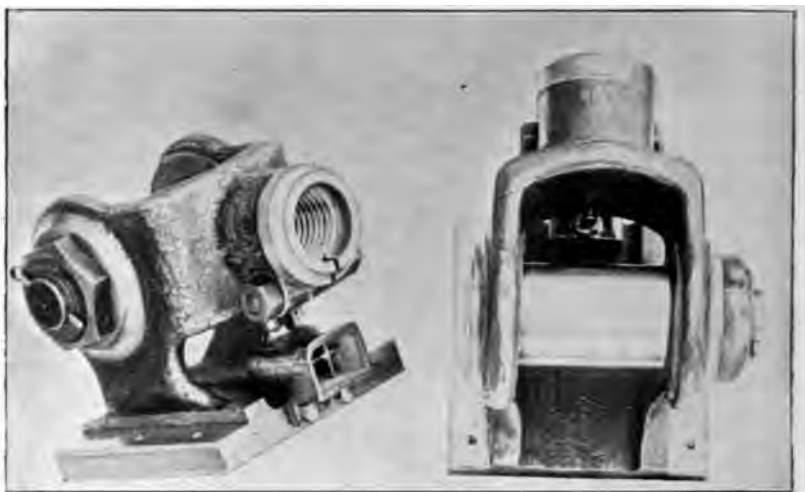


FIG. 10.

Two Views of 32-K.W. Crosshead.

In the latter case we can usually reduce the voltage by the shunt rheostat; but a slowed engine will usually prevent all efforts to get the voltage up to normal, the lights burn dimly with an annoying flicker, and no remedy can be applied until the set can be shut down and the governor spring screwed down.

There is seldom any good excuse for lost motion; liner material in all convenient thicknesses is in store to be required for, and even if these are not available, there is always sheet brass, or tin, or coffee boxes about, which can be hammered to the thickness and small area required.

Crosshead guides wear in time, permitting the lateral play, which is chiefly responsible for the oval erosion of the piston disk before mentioned. This requires some machining, but is quite within the capacity of the ship's force. In most cases the wear of the guides can be traced to insufficient lubrication; bad oil is especially pernicious at this locality, inasmuch as considerable wear may take place before it can be detected by noise.

CRANKS.

The crank end of connecting rods is almost invariably a stub-end connection; the brasses are made of the hardest obtainable bronze, and fitted brass-and-brass, that is, no parting piece or liner is placed between the flanges to be removed or reduced as the brasses wear, and it is practically intended that all probable wear will be resisted by the metal alone, except for some little lining up between the top brass and connecting rod, at the same time planing or filing away the flange surface.

If the metal is hard, but little heating, poor lubrication and tight fit apart, will be noticed; if soft, the wear is apt to be rapid, necessitating the taking of a good cut from the flange surface, true-boring in a lathe and new oil-ways. Scraping generally meets with little success, for the reason that the bearing surface is frequently reduced, which, in itself, is a direct invitation to further heating.

The calculations of the bearing surface of brasses are based on the thrust and weight to be applied at the journal, an empirical allowance of energy per square inch determining the total area required. Any reduction of this area must then cause heating. The proof has been directly demonstrated on board the *Puritan*, where all measures suggested proved tentative until the brasses were rebored.

A frequent cause of reduction in the bearing surface of crank brasses is want of alignment of the shaft, particularly if the wear on the oil-ways is at all serious.

Fitting these brasses, either new or repaired, requires good mechanical skill; it can be materially assisted by simply roughing the bearing surface of the brass with a half-round file, after the oil-ways are cut. The advantages are:

1. The roughed surface provides a slight clearance, which is not usually allowed, enabling the pin to establish a good working surface.

2. There is a polishing action on the journal which reduces friction.

3. The lubricant spreads more freely to all parts of the journal, particularly to the "dry line"—the line on which the pin is for the moment pressing. The expedient has met with good success in a number of cases, and is well worth trying.

Babbitt plugs and linings as used on ship's main engines prove inexpedient for cranks in the dynamo room. Babbitt boxes will replace brasses in most future engines, and are now fitted to the 32-K. W. sizes; they cannot be fitted to the present engines of smaller sizes from lack of sufficient clearance on the crank discs.

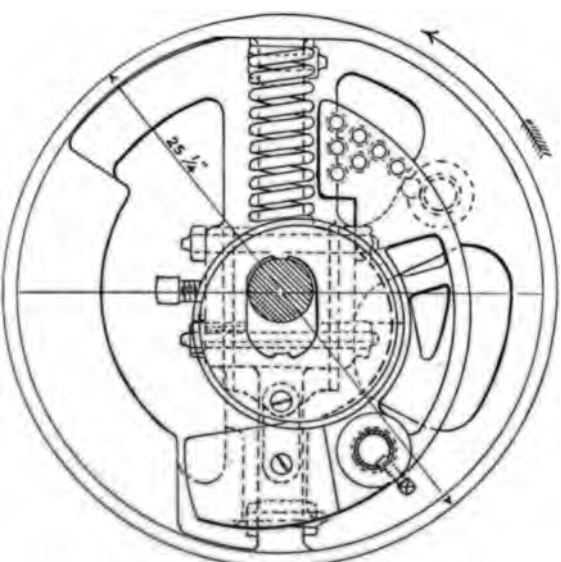
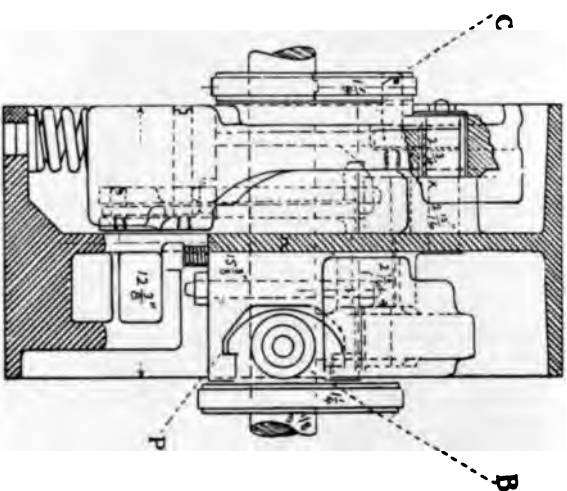
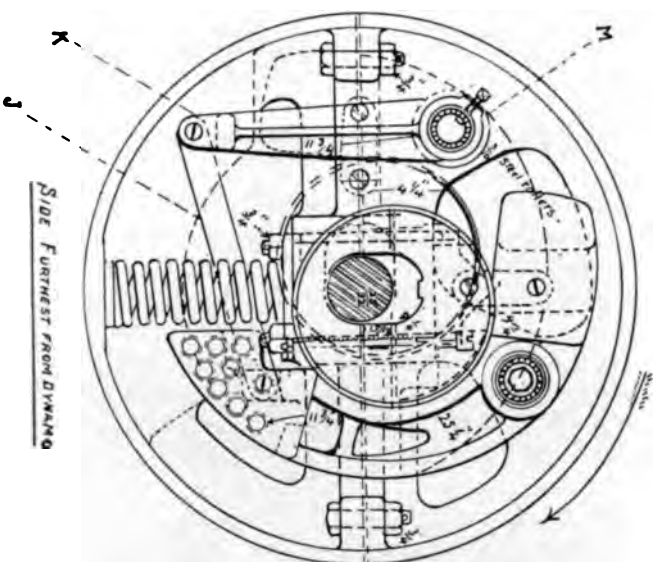
The rule that cranks should be placed at an angle of 180 degrees is imperative; to this any one will assent who, when in quarters aft, has listened to the pulsations of an A type engine located in a forward compartment. Ninety-degree cranks are quite certain to entail bad balance, racking strains on working parts, frequent lining up, vibration, lost motion and irremediable noise.

There is no manner of use in temporizing with a hot crank; dynamo men will make an effort, but the use of oil and water will only lead to the same result, which is shutting down and running another set while the crank cools and is examined for the cause of heating.

SHAFTS.

Springing and bending are the cases we meet with; flaw in material and breakage are rare.

A sprung crank-shaft is direct evidence of as well as of an improperly drained cylinder (7
ordinary case, however, is the springing of the shaft in lifting the armature, which has no support at the
bearing and the ring oiler bearing at the end of the shaft
ring to Fig. 5 and noting that the upper part of the
frame cannot be lifted, it will be clear that a crank-shaft
armature, with small clearance and handled carelessly
at any time to permanently spring the 2½ inch shaft
moved out. It is from a knowledge of this that the
shaft is so often put off until the last possible moment
Navy Yard facilities and workmen are not at



Form A and B.
FIG. 11.
32-K.W. Governor Assembly.

handling of armatures can be avoided by cutting down the end bearing boxes, making the shaft end accessible, and should be done at the first convenient opportunity, and, in addition, a short trolley rail and car should be installed for handling the armature to prevent some of the injuries to the insulation of armature coils due to the pressure of blocking.

Later engine shafts have a flanged coupling between the engine bearing and the armature, trolleys are provided, the dynamo field coils are laid in planes of 45 degrees with the vertical (Fig. 17), and the upper half of the frame with its two coils can be lifted off out of the way.

It requires but a small spring in these shafts to send them under the hammer and to the lathe; a new shaft is the more probable result, a matter of fully six weeks after the order has been placed.

GOVERNORS.

There is seldom a case of repair in which one or more parts of the governor is not involved. It has been admittedly a troublesome and annoying device. Much of the blame lies at the door of the device; a part of the remainder is attributable to the fact that repairs which would have helped matters somewhat were not made; the rest, to a hazy idea in some quarters regarding the mechanism and its action.

Fig. 11 is an assembly drawing of the 32-K. W. governor, A and B type engines. Fig. 12 is a sketch, not drawn to scale or corresponding with the actual assembly, drawn to show the connection and action of the principal parts.

A fly-wheel with fifteen-inch flange is divided medially by a light diaphragm (solid web in later engines, having lightening holes as shown), and secured to the engine shaft by a sleeve, feather and set-screws. The wheel is divided into two halves to admit of assembly. On each side of the diaphragm are the following parts:

A governor weight, *E*, working on roller bearings; a short link, *D*; a long link, *J*; a weight-shaft lever, *K*; a sheave block, *B*; a shaft, *M*, which pierces the diaphragm and is secured to the weight on the opposite side; and a stiff, coiled spring. The eccentric, *C*, is rigidly bolted to the sheave block.

The action is this:

The weight, *E*, thrown out by centrifugal for

short link, *D*, which transmits the power to the sheave block, *B*. This block is mortised at *H* to allow a motion across the shaft, the amount of motion being controlled by the spring; the eccentricity of the eccentric on the shaft center *A*, and consequently the travel of the valve, is thus changed by every motion of the sheave block. The sheave blocks on opposite sides of the diaphragm work at right angles, since the cranks are at 90° . The roller bearing is shown at *F*, and with the rollers in Fig. 11. The position of the block as shown is for greatest valve travel.

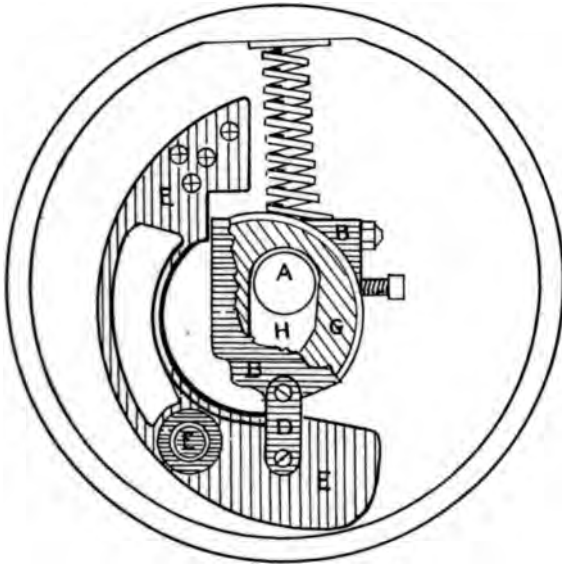


FIG. 12.

By merely tightening or slacking the governor spring, by means of a socket wrench entered through a mortise in the rim of the wheel, we can increase or decrease the number of revolutions for any given opening of the valve ports, or, having set the spring by trial for a desired number of revolutions (usually 400), any increase in the number of revolutions will automatically shorten the travel of the valve and admit less steam, any decrease will lengthen the travel and admit more steam; the governor thus automatically keeps the engine to the prescribed speed.

The long link, *J*, weight-shaft lever, *K*, and weight shaft, *M*, are merely connections between the two weights for the purpose of ensuring uniformity of action.

The first trouble with these governors appears as an elongation of the holes through which the link pins are inserted, and on which pins the links journal. Lost motion then causes a rapid increase in the elongation from the hammering action of the heavy governor weights; elongation of the holes in the long links appears, resulting in stress of the weight-shaft lever, and in some cases in breakage. The weight-shaft levers are made of cast iron, but should be of tough forged steel.

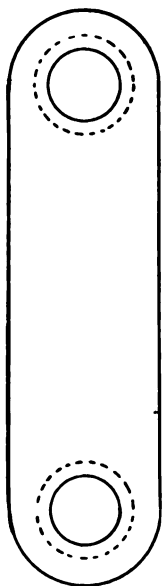


FIG. 13.

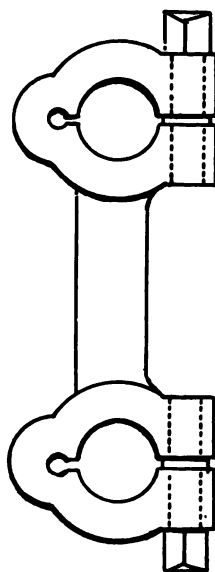


FIG. 14.

Lost motion in a device designed for the direct control of the engine speed is necessarily that to which that engine would be most sensitive, it is more than established in the case of links.

That a device so simple in construction as the link represented by the sketch of Fig. 13, and which can be readily made from boiler-plate or plate steel, is not at once substituted for the worn link has no other explanation than inattention and neglect. The noise of a loose link is unmistakable, even at some distance, and it will not do to attribute all noise in the governor to the hammering of the weights "against the rim of the wheel," as it is often said. The weights cannot hammer against the rim of the

wheel; they can, when running at light loads, hammer against the stops on which the weights take when at rest—particularly noticeable in starting up or shutting down—but at half load or more the feat is practically impossible, and any noise at such loads should immediately cast suspicion on the operation of the links.

Another expedient is to bush the link holes with bronze or steel.

The adjustable link shown in Fig. 14 is furnished with the C type engines; it is simple enough to admit of manufacture with our ordinary shipboard facilities.

The serious fault of the governor is in the roller bearings; it is purely a fault of design. In order to carry out the principle of "across-shaft governing," some means must be provided to



FIG. 15.

Pin, Sleeve and Rollers for Roller Bearing.

relieve the friction due to the pressure of the weight upon its journal; roller bearings were adopted for the purpose; the pin, rollers and sleeve are shown in Fig. 15. Referring to Fig. 12, the weight, *E*, actuated by centrifugal force and having its fulcrum at the link, *D*, exerts a pressure on the rollers which are on the shaft side of the pin. If the weight revolved about the pin the wear would be equal all around, but with the steady loads in use and the small amount of motion of which the weights are capable, the pressure is exerted at practically the same region at all times. The hard rollers bite into the case-hardened surface of the pin and sleeve, gradually producing deep grooves which, when once the case-hardening is penetrated, rapidly increase; the rollers then act as a sort of key to prevent rotation of the weight or jump from groove to groove, causing very jerky regu-

lation, fluctuating voltage and flickering lights; for motor supply such a condition is very objectionable.

Fig. 16 shows one of the corrugated pins, originally like that of Fig. 15, which was taken from the governor of a new engine after only six months' use; it is not the worst example.

When the worn pin and sleeve cannot be repaired or replaced the only recourse is to reduce the governor to a fly-wheel by blocking and govern with the throttle, involving steam waste and danger to the engine unless the carrying capacity of the main fuse of the dynamo is immediately raised as before explained.

Severing the gordian knot of this difficulty probably resides in abandoning the principle of "across-shaft" governing and adopting another which has proved successful under long use. Of these may be mentioned "line-shaft governing" as used with the Armington and Sims machines, also the tangential method of



FIG. 16.

Pin, originally like that of Fig. 15, showing Corrugations.

Ball and Wood, and the slip eccentric used by Sturdevant; both of the latter devices require that the governor is to be placed on the end of the shaft, where it always should have been, and where it is now placed in our C type engines and those for the Kearsarge.

The remedies at our disposal are to replace the worn pin, sleeve and rollers by new, which necessitates that spare ones should be on board; these should be of hard tool steel; or, to make a new pin, remove the sleeve and rollers and substitute a bronze bushing of equal thickness, a method that has met with great success at New York. The engine will not regulate as closely under the latter method, but by using a thinner oil—the usual lubricant thinned with kerosene—and making changes of load gradually it will be found to work successfully.

Governors are easily influenced by gummed oil or dirt and

should be cleaned frequently; this point is much neglected. A pertinent instance occurred on the ship from which the corrugated pin of Fig. 16 was taken.

Repair had been made by bushing with hard phosphor bronze, the first repair of the kind. At the end of about a week word was received that the governor would not work. Upon taking it apart it was found to be completely choked with gummed oil and dirt—had not been cleaned at all, in fact. When cleaned and oiled it governed as well as before. The head dynamo man naively remarked that his hands were “too large to clean those small holes.”

VALVE STEMS.

The too frequent breakage of valve stems has its ultimate cause in a jerky governor or shaft out of line. The original causes are that the length of the unsupported part of the stem is too great and that the guide casting is too light or has not sufficient strength for the purpose. Vibration and stress soon work the fastenings of the casting loose until, with loose guide and irregular stress from the working parts of the engine, the stem snaps. Two have been known to break in a single night.

Substituting a heavier guide casting and taking up lost motion will bring about a decided improvement.

THE C-TYPE ENGINE.

The C-type engine, of which we now have about fourteen in use, is shown in Fig. 17. Many of the faults cited have been eliminated in its design.

The engine frame is made more compact and is much stronger than the light, stilt-like construction of the former types; a flanged, through-bolted coupling is inserted between the engine and armature on the shaft, thus minimizing the chances of springing when handling the armature; the cranks are set at an angle of 180° , ensuring good balance and lack of noise; the governor is put on the end of the shaft and connected by a rod and rockshaft to the valve links which operate shorter stems in secure guides. In the last engine of the type furnished packing rings are put on the piston. It is a good engine, but has the old fault of roller bearings.

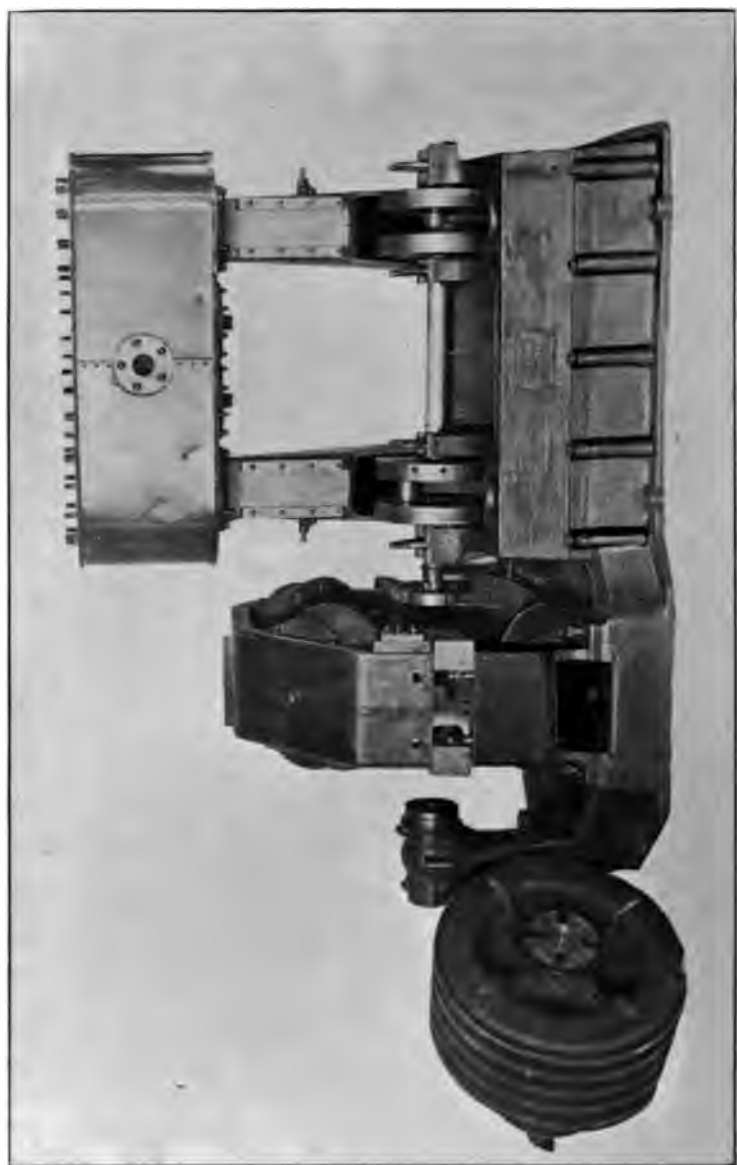


FIG. 17.

The governor, a radical departure in design from the old, but on the same principle of governing, is shown in Fig. 18.

Both weights are on the same side of the web, which does away with the long links, weight-shaft levers, weight shafts and nearly half the width of wheel rim, the necessary weight at the

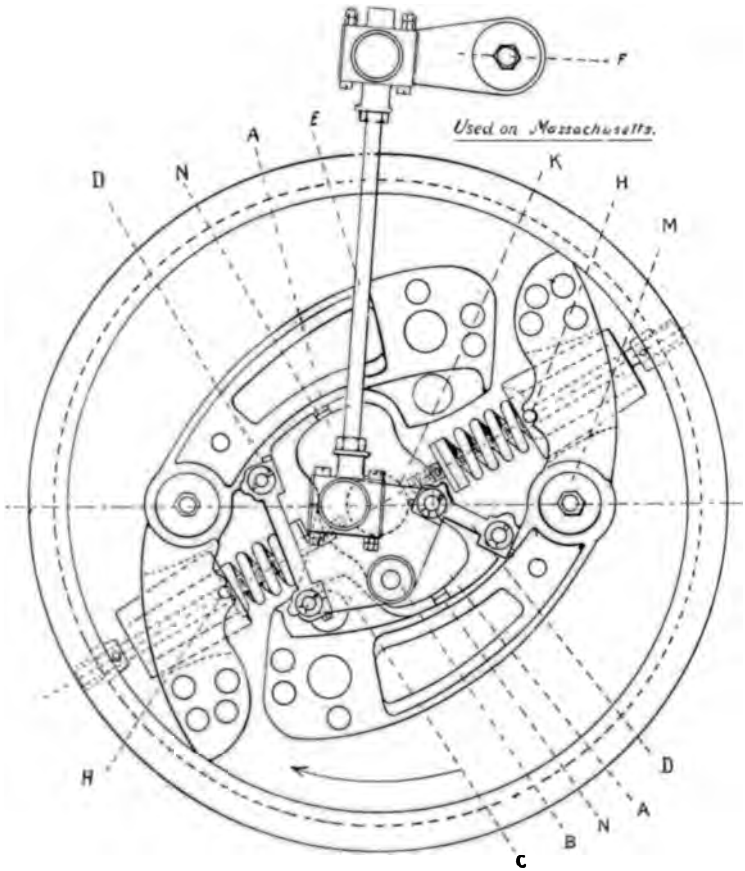


FIG. 18.

Governor Assembly, Engine, Type C.

periphery being obtained by thickening the rim. The construction is as follows:

The mass *A*, shaped somewhat like a guitar body, is cast in one with the web. A pin journal *B*, about which oscillates the

cam *C* (shown separately in Fig. 19), taps into this mass. The cam carries the adjustable links *D*, and the journal of the governor rod *E*, which rod operates the rockshaft *F*. The spring acts directly on the weights through the pin *H*.

The outward motion of the weights actuated by centrifugal force—and resisted by the spring—drags the links *D* and with them the cam *C*, which in turn shifts the center of the governor rod journal toward the center of the shaft *K*. The amount of throw at the rockshaft evidently depends on the eccentricity of the center of the governor rod journal, the full throw being represented by the position of the figure.

The weights take against the buffers *N* when at rest, and as these are cushioned, much of the pounding when starting or stopping is avoided.



FIG. 19.

Cam of C Type Governor.

The roller bearing trouble has come to the front in almost every one of these engines so far examined. In the Indiana the pins of all three sets were renewed last spring and fitted with bronze bushings.

Similar repair on the Massachusetts is awaiting a convenient opportunity, except that in this case it has been practically decided to put in new roller bearings of tool steel. The new set for the Massachusetts, from which Fig. 18 was taken, broke the pin of the roller bearing *M*, due to a flaw in the metal not discernible at the surface. When the pin was taken out a very decided corrugating action was found on its surface; the set had been in use but *three weeks*.

The governor of the Kearsarge and Kentucky sets has but one weight on roller bearings. The pin is made of hard tool steel and increased in diameter from $1\frac{5}{8}$ to 3 inches. There has been no experience as yet with the action on tool steel except in the case of the experimental set, representing the battleship (single set) design; this has been run at Schenectady for hours over a range of several months, submitted to all sorts of crucial tests, but now shows no sign of wear of the hard steel surface at the larger diameter.

Perhaps this may be the solution of our vexatious governor troubles in design. We who have the care and handling and annoyance on board ship sincerely trust that it may.

DYNAMOS.

Our dynamos are all of the constant-potential, "direct-current" order. Since the introduction of the smooth body armature—the modified Gramme rings shown in Fig. 5—but two types have been designed, the A type or form having the pole pieces in the vertical and horizontal plane as represented in the set shown in that figure, and the B type in which the pole pieces are in the diagonal planes; the frame is divided in the horizontal plane, flanged and bolted to admit of ready removal. These constitute the only important differences between the types. Experience with the type of Fig. 5 shows a great exposure of the lowest coil to all drippings of oil and water. This was particularly observed in the port set of the Cincinnati on her return this summer; the coil was so saturated with oil that it dripped from the wire when running it through the wiper.

Apart from the ordinary advantages of multipolar over bipolar constructions, our machines have put out of the consideration the effect of stray field upon the compass. Sir William Thompson has asserted that all dynamos will influence the compass on board ship, and points out that the danger is greatest at night, when heavy loads are carried and when the opportunities for observation are often impracticable. Tests made with both machines at full load on board the Puritan failed to show any disturbance, it is therefore supposed that the foregoing statement, made some years ago, refers to bipolar constructions, as the the multipolar was not in general use at that time.

Extensive trial has also proved that the electric lighting of

binnacles produced no appreciable effect. The new type V binnacles are fitted with electric lamps, except for those binnacles which are to be located at the hand wheels.

SPARKING.

Almost any violation of electrical or magnetic principles in design will produce sparking; it is also true of some errors of mechanical construction. These faults of design are matters for original and acceptance tests; the ship problem presents but few cases.

We have, however, in use two types of machine which, after a short time, spark beyond redemption at any stage of load or position of the brushes on the commutator; these are the Thompson-Houston and Siemens-Halske patterns; there are six all told in the service, and all 4-K. W. machines. Both types have a modification of the "ironclad" construction of armature, which, though very successful in small motors, will not answer for a dynamo. This construction differs materially from the slotted core design, whose teeth and slots are deep and narrow, and whose windings are practically cooper bars. The brushes also should make contact on three bars.

The Siemens-Halske machines in use in one of our ships spark so badly that the commutator is sand-papered two or three times a week to keep it in even fair condition.

Overload is the frequent cause of sparking, and will be shown by the ammeter, except in cases of grounds in the machine itself. It is not usual for the case to occur from extra loads on the lines in circuit, for the reason that the loads of the circuits are known; the general case is a ground somewhere, which should be tested out and removed; this the ground detector should show.

There is an occasional case of sparking from a broken coil, which can be readily detected by holding a file or screw-driver between any two pole pieces; the tool will be dragged in the direction of rotation whenever the broken coil passes. The repair consists in winding in another coil. A similar case is abrasion of armature coils; if the damage is slight it can be repaired with tape and shellac; if serious, a new coil must be put in.

Improper adjustment of the brushes is a common cause of sparking on board ship. It is intended that the connection be-

tween brush and commutator shall be a rolling and not a friction contact; this is a little difficult to explain, but can be demonstrated by trial.

A rolling contact can be assured by keeping the brush carefully trimmed to the angle at the bar and setting it with a light, complete touch. A brush jig is always furnished, and it is only necessary to file the brush to the exact bevel of the jig. Gauze brushes will seldom spark under these conditions. They are the only brushes worth trying; this of course does not apply to slotted core machines, in which carbon brushes are practically a necessity. A material assistance to good working between brush and commutator is the use of a little oil, that which can be taken from an end bearing on the finger, preserving that smooth, dark-brown color on the bars which is the best evidence of good working.

It is not rare aboard ship to see brushes bent by pressure, producing friction and wear on the commutator, the small area at the heel of the bevel making the contact which may not spread across the space between the bars, and causing sparking which is to be relieved by more pressure; this pressure, assisted by sparking, has one sure result, the scoring of the commutator or flats, both of which tend to farther and more severe sparking, and can be remedied only by dressing down the bars.

The proper trimming of brushes is much neglected; brushes require careful inspection to see that the contact is not ragged, scored or dragging shreds of waste.

LOW VOLTAGE.

The voltage of a dynamo for a unit of time is equal to the product of three factors expressed in the formula:

$$E = CNR,$$

in which

E = Total E. M. F. of the generator.

C = Number of coils in the armature.

N = Total number of lines of force passing through the armature, *i. e.*, the intensity of the magnetic field.

R = Number of revolutions of the armature, also of the engine in direct connected sets.

This formula affords us an excellent means of tracing faults in voltage.

The quantity C , the number of coils, is fixed by the design, leaving R and N , the speed and strength of the magnetic field, as the variables. The revolutions are tested by applying a tachometer to the end of the shaft and can be regulated by the governor to the rated speed (usually 400 revolutions); R then becomes a constant and the fault must lie in the field.

The intensity of the field depends upon the number of ampere-turns, which is equal to the number of single coils around a core multiplied by the current passing through the coils. Since the number of coils is fixed by the design, there must be a fixed number of amperes for any given strength of field. The problem thus becomes one of current alone, and shows that low voltage depends upon the simple principle that some by-pass is robbing the field coils of their due proportion of current.

There are several causes of weak field which are beyond the control of the shunt rheostat, or regulator as it was formerly called.

1. *Loose connections or bad contacts.* Every bolt and nut and screw which has anything to do with the shunt or series coils, and at the rheostat, should be slacked up, dirt and oil cleaned away and the contacts brightened up with sandpaper. All should then be securely set up.

2. *By-passes and grounds.* These occur from a collection of dirt, oil or water, or any combination of them, which can form a train to a neighboring wire or the metal parts either about the machine or rheostat.

A case of low voltage occurred on the Columbia which was finally traced to a train of copper dust and filings leading to the shunt field connections. Cleanliness of engine and dynamo should be rigorously exacted; it applies with especial force to motors.

There is an especial case of ground of the shunt rheostat which is a common cause of low voltage. Fig. 20 shows the shunt rheostat complete and also with the brass case removed.

A coil of "resistance" wire is wound continuously on each of two metal frames, as shown at *A*, the coils being connected in parallel to one of the shunt wires; the other shunt wire connects with the brush *B* at *C*.

The brush is insulated from a lever (not shown) which is operated through a rockshaft by the handle *D*. This brush

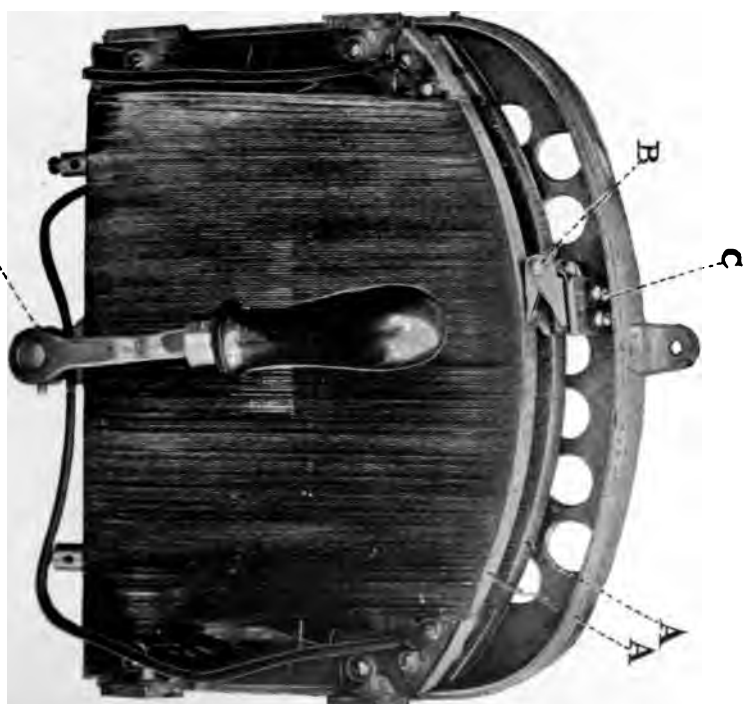


FIG. 20.

Standard Shunt Rheostat.

makes contact with the resistance wire on top of the frame, the wire being laid bare on the upper surface. Though neatly and tightly wound around the frame, the wire is likely to bulge after a time, be touched by the lever on the inside of the frames as it passes to and fro, and be chafed until the insulation is cut through and the wire grounded on the lever.

A sheet of mica or thick paraffined paper will remedy the difficulty until new wire can be obtained for rewinding the coils.

3. *The series shunt.* The office of this device, commonly but erroneously spoken of as "the compounding," seems to be little understood.

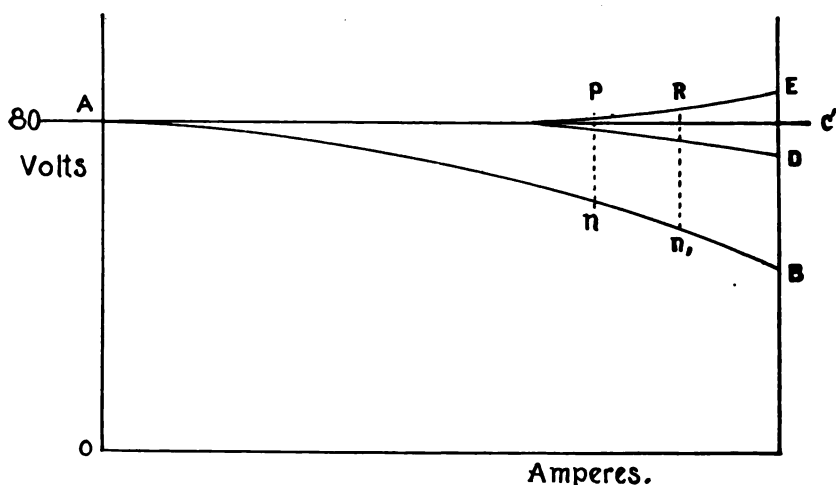


FIG. 21.

A short explanation of the effects of the shunt and series coils and of the series shunt on voltage will make the subject clear.

Fig. 21 represents a theoretical characteristic (the "indicator diagram" of the dynamo) of a compound dynamo in which the ordinates are volts and the abscissae amperes. In starting up—since no current is passing in the external circuit and hence none in the series field—the voltage is raised by the shunt field alone, hence all curves originate at *A*. Were the shunt field to continue to act alone (we will presume there is no shunt rheostat) the curve produced would be *AB*, which curve indicates that the voltage of an unaided shunt field falls as the load is increased, and at full load would be insufficient for anything but redness in the lights. The desired curve is the line *AC*, but as a matter

of experience engines tend to slow at high loads, producing the curve AD , and for that reason a slight up-curve, as shown by AE , is preferred to AC . To supply the increments of voltage p_n , p , n , necessary to bring the voltage of the curve AB to that of AE , is the function of the series field. The action of the combined fields makes the dynamo compound and self-regulating.

It is mechanically inconvenient, if not impracticable, to obtain

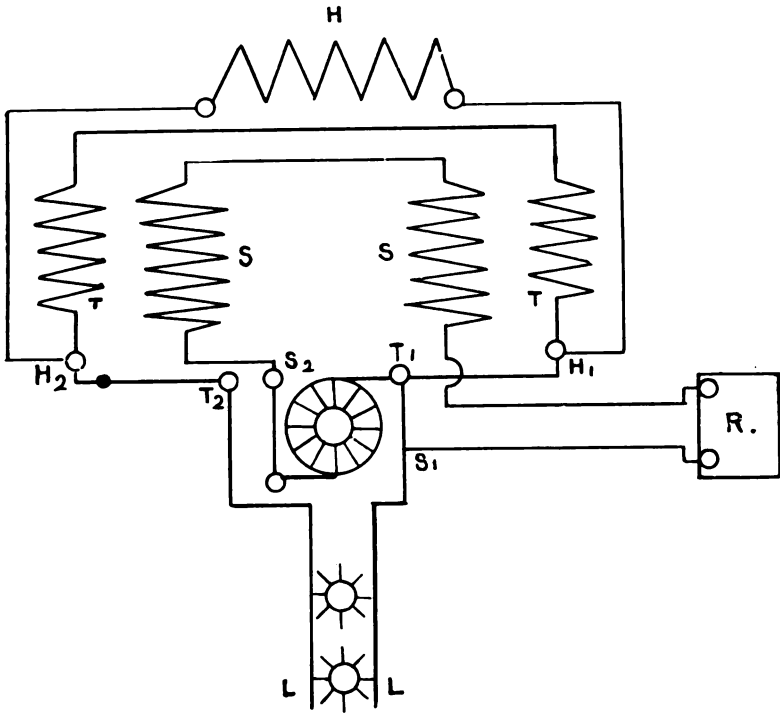


FIG. 22.

those nice lengths and resistances of series and shunt windings which are the necessities of the case, and coils are cut to lengths convenient for construction; the series coils are designed for less than the required resistance, and a series shunt is connected across the terminals of the series fields to afford a shunt or bypass for the current to be abstracted; the shunt rheostat regulates irregularities of resistance due to original construction, temperature, etc.

Fig. 22 shows diagrammatically the system for both fields. LL is the external circuit or line; S_1 and S_2 the terminals of the shunt field S ; T_1 and T_2 are the terminals of the series field T ; H_1 and H_2 the terminals of the series shunt H . It will be apparent that any current in H does not pass through T , but goes out to the line through H only.

The actual series shunt is sketched in Fig. 23. It is usually located on the back of the head-board, with a removable cover whose top is made of wire gauze. It consists of copper strip

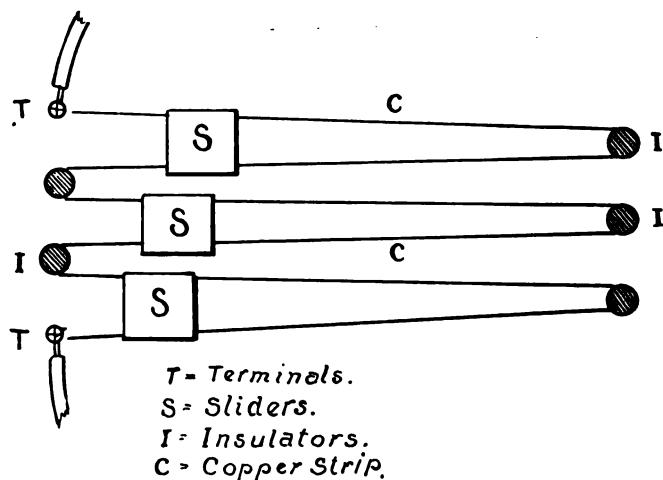


FIG. 23.

zigzagged around insulators A , on which clamp-sliders, Fig. 24, are placed. By moving the sliders to the left the resistance of the shunt is decreased and more current is taken from the series circuit; by moving to the right the opposite effect is produced.*

The series shunt is adjusted on acceptance test and it is not expected that any alteration should afterwards be made or necessitated.

* Left and right here refer to the figure only, the terminals being on the left. In actual machines the location of the terminals is determined by convenience. In narrow dynamo rooms like those of the Boston and Atlanta the generating sets must be installed end-to-end in order to obtain room, and in this case one armature would turn right-handedly (with the sun), the other left-handedly, and the terminals would be different.

On acceptance tests, immediately after taking the cold resistances, the sliders are clamped to the series shunt, preferably midway from the terminals; the rheostat handle is set midway between high and low, or on the middle point or block of circular type rheostats, these midway positions affording the greatest range of control of regulation. When the machine is started the voltage is adjusted to 80 volts by the series shunt sliders for the heat run of four hours, and then adjusted for a full due while the machine is hot. The sliders should be on the same line and a permanent mark made on the case to indicate the proper position. Usually a machine which develops the proper voltage both at full load and no load will produce that same voltage at any other load, that is, within the limits of a volt on either side; anomalies occur.

In a 2-K. W. machine tested last winter, having no series shunt, the voltage at full and no load was exactly 80 volts, but

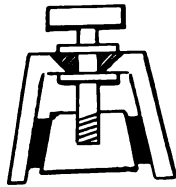


FIG. 24.

at six amperes the voltage increased to 90. In testing engine regulation with this machine the voltage reached 110 when breaking from full to no load in one step; this would be sufficient to burst every lamp in circuit. In a 24-K. W. set tested a close regulation to 80 volts occurred at full and no load, but increased to 89 volts at half load; adjustment of the series shunt brought the characteristic nearly to the ideal over the whole range.

No harm can come of readjusting a series shunt (unless it be overlooked in paralleling machines) if only it is done intelligently; at the same time it is a bad school for dynamo tenders. Nor should an occasion arise until, in old age, the machine develops erratic action which the ordinary expedients will not reach.

The foregoing explanation demonstrates that the voltage of a machine is easily deranged by tampering with the series shunt. This has been developed in the case of a ship that came to the

Navy Yard with an apparently inexplicable case of low voltage. Connections were overhauled, grounds tested out, shunt rheostat examined, and all to no purpose; finally recourse was had to the series shunt, and the sliders found to have been shifted by a man who, in cleaning out some oil and dirt, had moved them and put them back as nearly as he could remember. No one on board had been able to locate the difficulty.

Our dynamo troubles are so few that a little care and intelligence should control them handily, and these qualities will be improved by frequent inspections, above all things for cleanliness.

A certain crack ship in the service had a dynamo room whose bright shellac and general condition would please the eye of any captain; when it came to repairs there was dragged forth from the spiders, armature body and field coils a collection of oily muck and dirt that could have produced a series of troubles; it had deteriorated the insulations as it was. This sort of cleanliness does not, as far as electricity is concerned, partake of any approach to the godliness mentioned in the adage.

Lack of cleanliness, and salt water are the inveterate enemies of electricity on board ship.

One of the difficulties in design of armatures and field coils is obtaining good radiation of the heat generated in the coils. Heat not only increases the coil resistance, occasioning the waste energy of internal losses, and hence decreased efficiency, but deteriorates the insulation of the coils. The non-conducting property of insulation dictates that it be reduced to the lowest advisable thickness; at the same time there is a limit of reduction which it is not safe to pass; our restriction that the heat rise in the coils shall not exceed 50° F. above that of the surrounding atmosphere after a four hour run has necessitated a large armature comparatively; the necessity of this limitation is apparent when we consider the high temperatures of the average dynamo room and the influence of the ultimate temperature to which the coils will be subjected. Oil, in addition to its evil effect on rubber and dirt, increase the difficulties of non-conduction in their cycle of effects.

In some ships *paint* has been put on the end c appearance' sake, a material more baneful to arm oil and dirt, not only on account of the de oil on rubber, but through the non-conduc g layer

once applied it cannot be removed, and when dirty is to be cleaned by another coat of paint, producing more resistance to radiation.

When an armature burns out the accident usually occurs, from a variety of causes, at these very end conductors.

The end conductors of a ship in the service were painted blue; the men of a rival ship, consumed with envy, painted theirs green.

A plea is entered here for more frequent exercise in paralleling.

A veil of mystery and danger is thrown around the subject which it little deserves. Compound machines are paralleled everywhere in this country now-a-days; they will not do it in Europe. But it was not until an electric light station became practically wrecked in New York that our best experts found the solution; they now run the negative leg straight, fuse the equalizer and put an automatic circuit breaker on the positive leg; a machine can be in no danger with this arrangement.

Paralleling compels a man to know his machine or trouble ensues.

The dreaded danger lies in the fact that if one machine A gets a certain increase of voltage over the other machine B, A will cause B to reverse and the whole load will fall on A; B becomes a motor and is likely to rip out its brushes, if of the ordinary copper type, when turning backwards; if the current thrown on A is over 50 per cent. above A's rated capacity, A's armature will probably burn out. This is a rather startling array, but is quite within control when the conditions are known, so much so that commercial machines run along in parallel for hours and days together without a thought of danger, *but they know their machines.*

Reversing an armature, and therefore paralleling, depends on the internal resistance, and hence upon the efficiency; the lower the internal resistance, the higher the efficiency, the less will be the voltage to turn that armature backwards. Taking a characteristic by noting the voltage for each load thrown on, no change being made in the shunt rheostat, will show whether the two machines differ sufficiently, at *any load or loads*, in their voltages to endanger the lower machine's reversal. With our machines there is little chance of it; they are compounded very closely to the straight line, and have characteristics so nearly similar that the matter can be taken on trust, but this does not mean that

it is always to continue so; a characteristic should be taken from time to time to see that it is so.

As long as the difference of voltage does not exceed three (3) volts everything is safe, but the voltages should be kept as nearly as possible to the standard by the rheostat to ensure safety.

First see that both machines are poled right; being in alternate use the voltmeters ought to be connected right and would tend to move in the wrong direction, would not indicate, if the poles were reversed; get both machines up to 80 volts and divide the load as equally as possible between the machines, then close the equalizer switch, called in the instructions the multiple switch. (See Appendix A.)*

Each machine will take up half the load and both will run along practically synchronously and need only the attention of a motion of the rheostat handle now and then. It is better to parallel two machines than overload one, and it is good practice whenever heavy loads are to be carried. It is better not to put motors carrying variable loads on the same bus bar with lights, as a flickering is sure to occur; and for the reason that the mushrooms of a search-light occasion sudden jumps of current within wide ranges, that light is preferably to be run by another machine.

VIBRATION.

The vibration of a generating set in good working order is purely a question of foundations; with well braced decks, bed-plates resting on two inches of oak to cushion the tendency, and thorough bolting, the difficulty is rare. Two service examples will illustrate the fault.

In the Columbia the dynamos rest on a light deck over a very

* As long as the characteristics of the machines are practically the same it does not matter whether the equalizer is closed first and the circuits turned on, or the circuits divided equally between the machines before the equalizer switch is closed; the above is the method prescribed by the Instructions in the Electrical Journal of the ships and, of course, is official. It is beyond doubt the safer plan for the reason that, having divided the load beforehand and adjusted the voltage for that load, no change in the voltage of the machines can occur, as it might if they were allowed to adjust the loads for themselves, that is, provided the loads remain constant; if they do not and there is any difference of potential created by the extra load sufficiently great to be critical, reversal will occur.

Safety lies in keeping the characteristics the same for all machines at all stages of load and keeping to the instructions implicitly.

high coal bunker. Sufficient support is given by stanchions in the bunker, but no lateral strength is afforded other than that of the deck framing.

So great was the vibration produced that the captain could not write at his desk until the engine was slowed to 350 turns; the greatest obtainable voltage at this speed was 70, the lights showed a bright red.

Four heavy stanchions for each machine were securely bolted to the deck and to the protective deck overhead, with flanged toes bolted to the bedplate. This expedient checked all vibration.

In the Amphitrite vibration was partially remedied by shoring up the deck underneath. The vibration still exists to a marked extent, as any one can testify who will stand on the port side of the quarterdeck or take hold of the bridge rail.

As a matter of physical interest it may be mentioned that in both of these cases distinct nodes and loops were developed. In the Columbia the captain's desk was near the center of a loop, and hence received the full amplitude of the wave.

NOISE.

Many noises which occur have been mentioned; generally speaking, none should be allowed to exist.

Piston valves develop a little pounding, due to wear, by ballooning against their seats; oil will delay its occurrence. There is a very good valve in the market whose wear is as regular as that of the D-slide valve, and whose wear rather enhances its fit; it is known as the telescopic valve. It will operate even with the valve chest bonnet removed, and has the distinct advantage of acting as a voluminous relief valve in a critical case of water in the cylinder.

There is a noise peculiar to cylinders explained as a combined whistle and grunt. It is due to the friction of the piston, and is quickly relieved by a little oil in the steam. Pounding in the cylinder is generally due to water; if free of water it is good evidence that the load is not evenly distributed between the cylinders and that the valves need resetting.

REDUCING VALVE.

The frequent complaint against these valves is that they are not adjustable. A gauge with its branch to the steam pipe would

be a great convenience and assistance as showing the actual pressure of steam delivered to the dynamo room. An adjustable reducer is in a sense a throttle, and will produce the evils of throttling down if so used.



FIG. 25.

Stratton Separator.

SEPARATOR.

The Stratton pear-shaped design, shown in Fig. 25, is that ordinarily installed; there is also a cylindrical type. They work well if properly handled, and can be highly recommended. Those furnished have been too small; the rule should be that the capacity should be from four to five times the volume of the cylinder, in order to cushion the engine pulsations and avoid the objectionable vibrations of the pointer of the steam gauge dial. A large capacity separator will also take care of much of the water which comes over to the cylinder on that critical occasion

when a machinist shifts from one boiler to another without sending word to the dynamo room beforehand.

The breakage or blowing out of water glasses is a common case. In some cases it is due to accident, but is more often due to poorly annealed glass. Any effort to work a separator without a water glass is merely courting accident; it was the occasion of the breaking of a connecting rod and the four stanchions of an engine in one of our ships.

The glasses furnished to the chief engineer are trustworthy, will fit, and will be found to last for long periods.

There is a point about separators which has come under observation and which has a bearing on occult cases of water in the cylinder.

The separator is a condenser; owing to the fact that the trap sometimes—though rarely—gets out of order, or needs cleaning, the water is drained through a pipe leading directly into the dynamo room. The dynamo watch can make use of this connection for the purpose of obtaining an odd bucket of water or two; it is a case that can be remedied best by some vigorous administration.

THE SWITCHBOARD AND CIRCUITS.

Before entering upon faults in this direction, and which have been covered in specifications, it may be well to consider the unsettled problem of the behavior of our installations in action. Circuits are now installed to the greatest possible extent below the protective deck or behind armor, exposed branches are run in the most direct manner feasible, and all lines that could be reasonably exposed to the action of shot and shell or develop grounds that would affect or derange the working of any electric light or device needed in action are provided with cut-outs where they do not connect to the switchboard.

Lieutenant W. S. Sims, U. S. N., in a report made on the battle of the Yalu in 1894, says:

“Captain James” (now retired, but formerly connected with the Japanese naval establishment) “says that long before the end of the engagement every electrical communication in the Japanese vessels had entirely failed; that candles and lamps had to be used in all lower compartments, engine rooms, fire-rooms, bunkers and magazines; that the search lights were useless; and

that, fearing the torpedo boats, they were unwilling to risk continuing the action after dark. It is not clear how the electrical communications were damaged, but it is said to have been due to the large and complex vibrations set up in the ship by the discharge of the heavy and secondary battery guns and by the impact of the enemy's shot. It is said that the lights were at first fitful and finally failed entirely."

No more succinct information has been obtained as far as is known.

The responsibility for the results reported has been laid by a high naval authority upon the dynamos, their method of installation, and the circuit appliances in use.

Applying the experience to our own case, we have little to fear from our machines or their installation, excepting as regards location. It has often been pointed out and urged, and becomes more pertinent day by day, that ships, especially battle-ships, should have their plants divided between two dynamo rooms widely separated in the length of the ship.

It needs no argument, but is for some reason completely ignored.

It may be an open question whether our switchboards and the porcelain insulating blocks of wiring appliances—feeder boxes, junction boxes, switches and the like—will stand up under the shocks and vibration of the Yalu report, especially under a heavy shock within the ship.

The panels of the switchboard are of slate, a fairly fragile material, and have many perforations for the circuit leads which increase their weakness; still slate has a distinct advantage over marble, from the diagonal nature of its cleavage. To the very fragile nature of porcelain for insulating blocks is added the fact that the holes for the screws which hold the electrical connections to the blocks are near the edges and corners of the block; the blocks are most likely therefore to break at these screw-holes and release the connections; mere hammering on a bulkhead where wiring appliances are installed is often sufficient to break the blocks.

It is submitted that these loose and vibrating connections, the possible contact—particularly a vibrating contact—of connections of opposite polarity to make short circuit, and the jarring together of circuit connections at the switchboard to cause grounds and

by-passes, will occasion that very flickering and failing of lights spoken of in the report.

It is now required that each panel of the switchboard shall be held by a separate framing of oak—like a picture in its frame—which will afford more security.

The certain safeguard is to make the switchboard panels and insulating blocks of a strong, tough insulating material which will minimize all liability to breakage. Fibre and vulca-bestin (a vulcanized mixture of asbestos and rubber composition) have been suggested, but both are disposed to absorb oil and become poor insulators. The material *par excellence* is micanite; mica would be preferable, but cannot be obtained commercially of sufficient size. Micanite is manufactured by pressing together thin, formed pieces of mica laid in cement; any desired form and thickness can be obtained. Micanite has the objections that it splits, scales or becomes ragged, but these can be prevented by casing or facing with some insulating substance, vulcanized rubber composition for example.

As for search-lights, the exposed condition of their leads almost ensures that they would be destroyed within a short time. In a day action the projectors would be sent below; the leads should have a connection installed behind armor to which loose wires could be connected when needed for night use, and when the projectors can be mounted for use; the subject has not been taken up thus far.

The general excellence and convenience of the present switchboard design, except in so far as the material of the panels is concerned, eliminates it from the question of faults; some changes or rather additions will have to be made, however, to accommodate it to the use of the number and variety of power circuits for which no design has as yet been presented. Small motors can be grouped on lines from the ordinary switchboard; others will probably have panels and circuit connections of their own, carrying knife switches and automatic circuit breakers similar to those used in electric light stations.

The automatic circuit breaker consists of a double pole switch which closes against a strong spring and is held to its closed position by a spring catch. A solenoid adjustable for the permitted overload actuates an enclosed plunger which trips the catch and the switch flies open. Differences in design arise

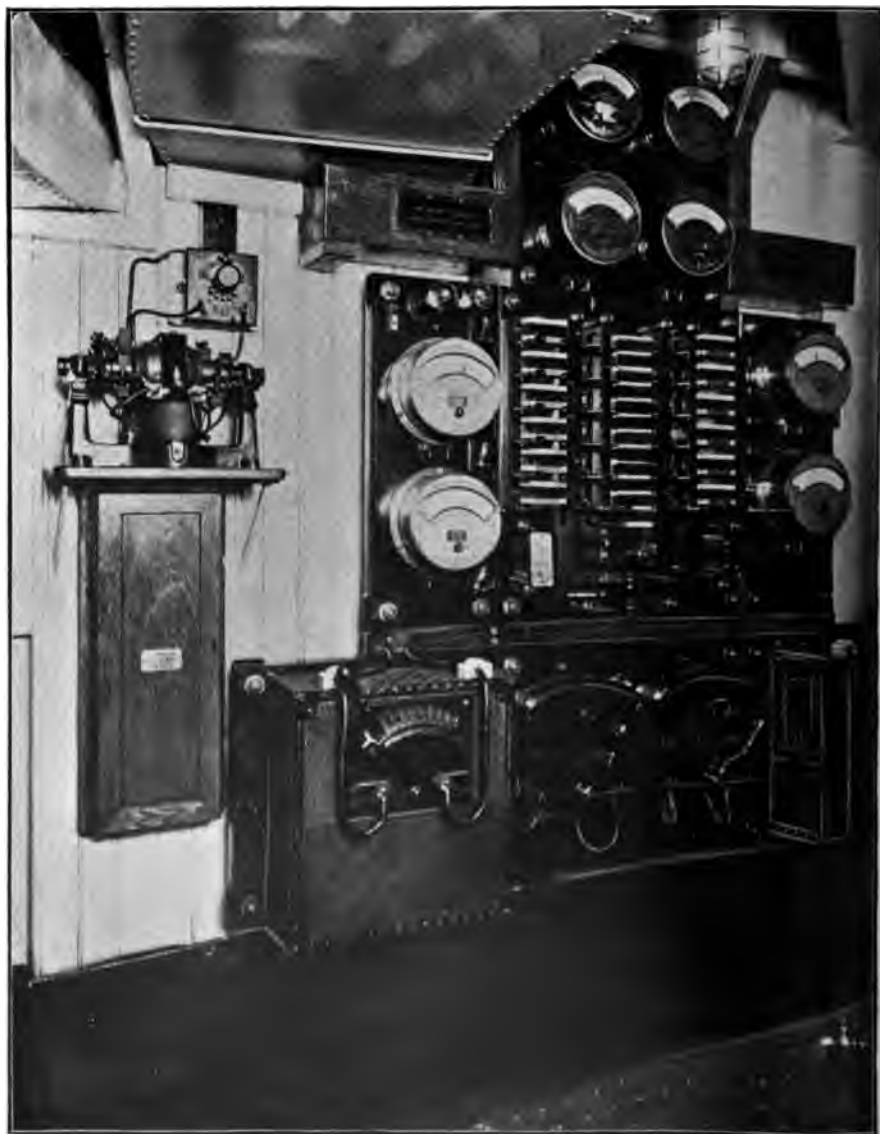


FIG. 26.

Puritan's Switch-Board.

chiefly from the manner of extinguishing the heavy spark at break. In the "I. T. E." design a block of carbon is fitted to both the switch tongues and jaws, the blocks extending far enough to preserve a contact after the tongue and jaws have separated. The resistance of the carbon somewhat reduces the spark, which at the end acts on the carbon alone and not on the copper connection. The carbons can be readily and cheaply renewed. In the General Electric Co.'s design an electromagnet is placed near the sparking contact and breaks the spark by drawing it aside, as in the well known experiment of a magnet on the electric arc; this design is commonly called "the magnetic blow-out."

Automatic circuit breakers are much more reliable and positive in their action than fuses, and, what is better, can be easily tested for operation, which, of course, the fuse installed cannot.

The voltmeters and ammeters are constantly in state of improvement, and even now, notwithstanding the excellence of Mr. Weston's designs, which can be safely recommended as unequaled, experiments are making at his works in perfecting the alloys. The circular type of instrument is standard, the ammeters being shunted from one leg of the circuit instead of taking the entire load.

Fig. 26 shows the switchboard of the Puritan. The upper board is for the search light instruments; the boxes for the ammeter shunts appear at the right and left near the top; the transformer, Crocker-Wheeler type, is shown resting on the battery transfer case; the rheostats for the search lights and shunt fields are at the bottom. This switchboard has a position which is very much exposed to particles of oil, when the oil-guard of the neighboring engine is not in place, but no other place is available, one side of the dynamo room having to be left clear for access to the armor bolts.

The lamp ground detector should, and no doubt will, be replaced by the Weston circuit tester and ground detector shown in Fig. 27, which is simply a voltmeter reading both ways from a central zero. The great fault of lamp detectors is that unless there is a *dead ground* the lamp will not flash up; imperfect insulation resistance as low as 100 ohms will produce no indication. In the Weston device lowered insulation is at once indicated by the deflection of the pointer and its direction; it is not

to read that it would be direct reading, which would occasion expensive design, the defect is sufficient, the calculation being made mentally, or by reference to a table used when testing insulation resistance by the simple, excellent method known as the volt-meter test, to be explained later on.



FIG. 27.

Weston Circuit Tester and Ground Detector.

Many of our switchboards have been insufficiently supported, thereby bringing a stress upon and loosening the circuit connections of the panels. The weight should be taken by a shelf, or at least a plank supported by posts. Accessibility of the connection at the back of the board is imperative.

Safety in paralleling dictates that each set should have its own voltmeter; the practice has been to allow two voltmeters in case of three machines.

Wire. The use of so many kinds and conditions of wire has rendered it absolutely necessary to co-operate with manufacturers and tie down the construction to minute details. Lead covered wire has fallen into disuse from the difficulty of its repair, the manipulation of its weight, and the almost certain breakage at bends and angles. It has fallen far short of the anticipated advantages claimed for its use in heated locations, and is peculiarly susceptible to any electrolytic action; in the underground work of cities where trolleys are run the companies will no longer guarantee it, and lengths have been taken up in Brooklyn on which no evidence of the lead remains beyond a blackish-white salt, due to the action of the trolley currents.

The general principles of construction of standard wire are;

1. A protection against grounds, should the vulcanized rubber strip or flake, by means of a thin layer of pure Para rubber adherent to the copper conductor.

2. Insulation by vulcanized rubber for the voltage to be used.

The combined insulation of the two foregoing coats is nearly double that required by the underwriters' specification for 125 volts.

3. Circularity of section over the vulcanized rubber by a layer of cotton tape soaked in an insulating compound, to ensure a neat water-tight fit of the gaskets—the conical, perforated plugs use in the wiring appliances—mere braid forming too rough a surface for the purpose.

4. Preservation of these layers from stripping or flaking off, or from mechanical injury, by means of braid.

A test of the insulating quality of our wire was made by subjecting to the stress of 5000 volts, static charge, which it resisted for nearly an hour. It stood the voltage of an X-ray machine for nearly a minute; this voltage could not be measured but must have been very high.

One great improvement in wire has been the introduction of cables for the interior communication leads by which a few hundred feet will replace the miles of single wire heretofore made necessary. The cable is not only applicable to the bell circuits, but will answer for a number of instruments. These cables are

shown in section in Fig. 28, and have from 2 to 20 conductors. They are installed in the same way as other wire and run into connection boxes taking 20 or 40 wires. Within the connection boxes are the tags for the leads and from them branches can be run to the desired locality by smaller cables, the whole admitting of a thoroughly water-tight connection. A wire in each layer is braided in white for convenience in counting.

An example of some inferior wire which has been used occurs in the bunker and water alarms of the Montgomery and Detroit. This wire is ordinary blasting wire, consisting of a copper conductor and a light layer of vulcanized rubber. Installed over and within a couple of feet of the main boilers the insulation has stripped and flaked, short-circuiting both systems.

Circuits. It may be better perhaps to predicate this subject upon specifications which, apart from the ordinary rules of wiring, have been drawn from experience in service.

"Conduit will be used for all spaces in the water-tight system. It is to be preferred" (to molding) "in all other localities; but in spaces where it may not be desirable to run it over woodwork, as in chart houses, emergency cabins and officers' quarters, standard wooden molding may be used."

Naval constructors define the upper limit of the water-tight system as the stability deck; this would take in all the ship below the main deck and include the superstructure of constructions like the Maine; hence conduit is to be used everywhere, practically, which is not excepted in the specification.

The conduit is iron or steel pipe, brass about the magazines, etc., lined with rubber or bituminized paper; paper is the better for heated locations, such as engine and boiler spaces, drum rooms, etc., rubber where bends and angles occur and where paper would be apt to burr and interfere with drawing the wires.

Molding is open to many objections. It is made of wood, lately expunged from ships as far as practicable; fireproofing is said to detract from the insulating properties of the molding. It requires excessive drilling and tapping of the bulkheads, a screw every six inches of the length, to secure the backing strip of each line run, a serious and expensive delay in addition to weakening the plate.

As the electrical installation must wait upon the other details of construction about the ship, the wiring plans undergo frequent

UNIT CONDUCTOR.	
Dia. over Copper (No. 16	.05082
B. & S., 2.583 cm.) . . . . .	.081
Dia. over Para Rubber. . . . .	.1425
Dia. over Vulcanized Rubber .	

CONDUCTORS.		DIAMETERS.																		
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Over Conductors . . . . .	.288	.307	.314	.325	.338	.351	.365	.379	.393	.407	.421	.435	.449	.463	.477	.491	.505	.519	
Over Tape	318	370	406	447	480	500	533	577	622	633	655	686	691	711	732	756	779	800		
Over Vulcanized Rubber	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Over Tape	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Over Braid	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

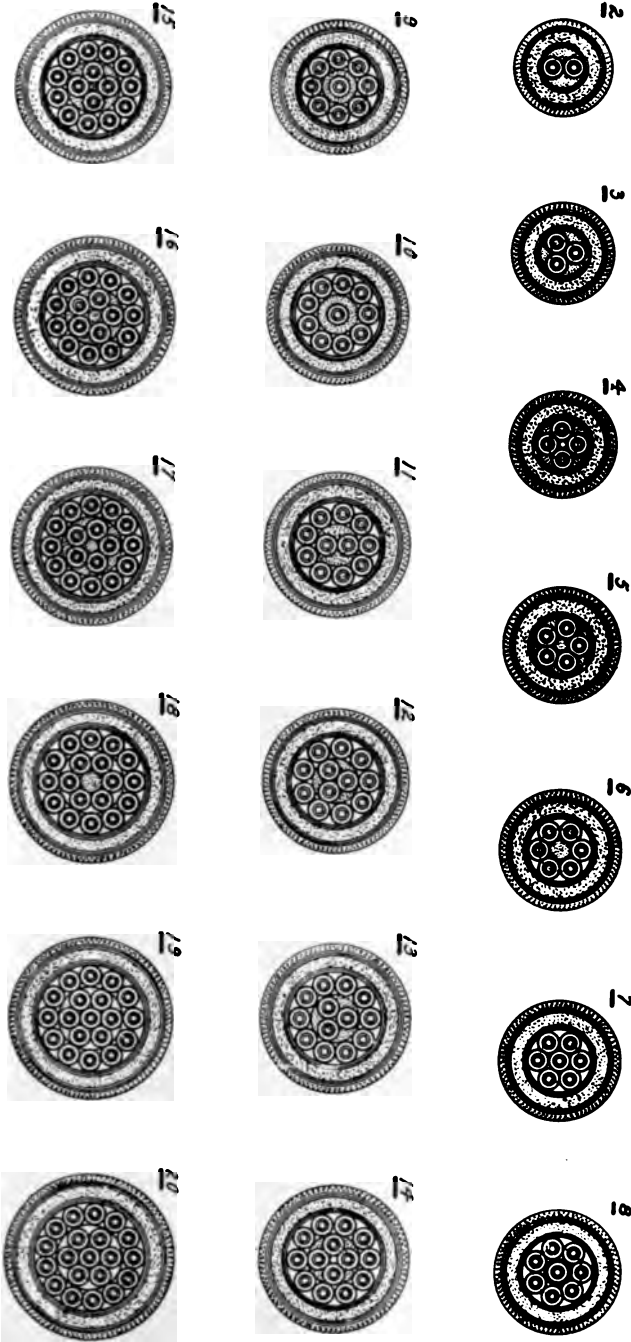


FIG. 28.

changes from the original design and molding lines are turned and twisted for every sort of device or lead of piping; it is too expensive or involves delay to rip out a whole line and re-install, and a makeshift must be designed involving numerous joints and turns, or, in cases where the piping is to set well off the bulkhead, recourse must be had by way of the interior of a bunker, where coal will soon use up the molding; in the New York many of the lines in bunkers are now bare, the molding having disappeared.

The capping warps and exposes the wires; if the screws are placed at the side, much the better plan, there is still exposure at the edges, particularly those of mitred joints. It requires an expensive line of tubes through bulkheads and beams.

Conduit requires only a strap and screws at each frame or about every three or four feet. It can be bent around piping without other support. It can be screwed into flanges at bulkheads and beams without other device. It can be used as a bracket or pendant for fixtures, especially in machinery and boiler spaces, where the use of molding would only admit of the installation of a hand portable. It is available for approaches to the turret leads, where hydraulic power is used, when molding would be inadmissible; within the turrets most of the leads must have a flexible covering, rubber-lined hose or flexible conduit for example.

Some former trials of unlined conduit did not prove satisfactory on account of the effects of condensation. Paper and rubber are non-conductors of heat, and if the original installation is exposed, inside and out, to a moderately cool temperature, the dew-point should be sufficiently low to obviate such a result, and no access of air for a long period of time should afterwards occur provided care is taken to keep the boxes of wiring appliances closed and tight in conformity with their water-tight design. It is from this cause that condensation is most likely to appear; it would ordinarily be trivial in amount and drain into the distribution boxes and be eliminated from there. In repairing a ship 50 caps to the boxes were missing and the boxes found to be filled, choked and short-circuited by a mass of ashes and dirt caked by oil and verdigris, the latter the result of the use of hose in washing down bulkheads. These caps are now fitted with a chain secured to the corner screw of the cover, and not only should the caps be set up hard with a wrench, to prevent tampering with by un-

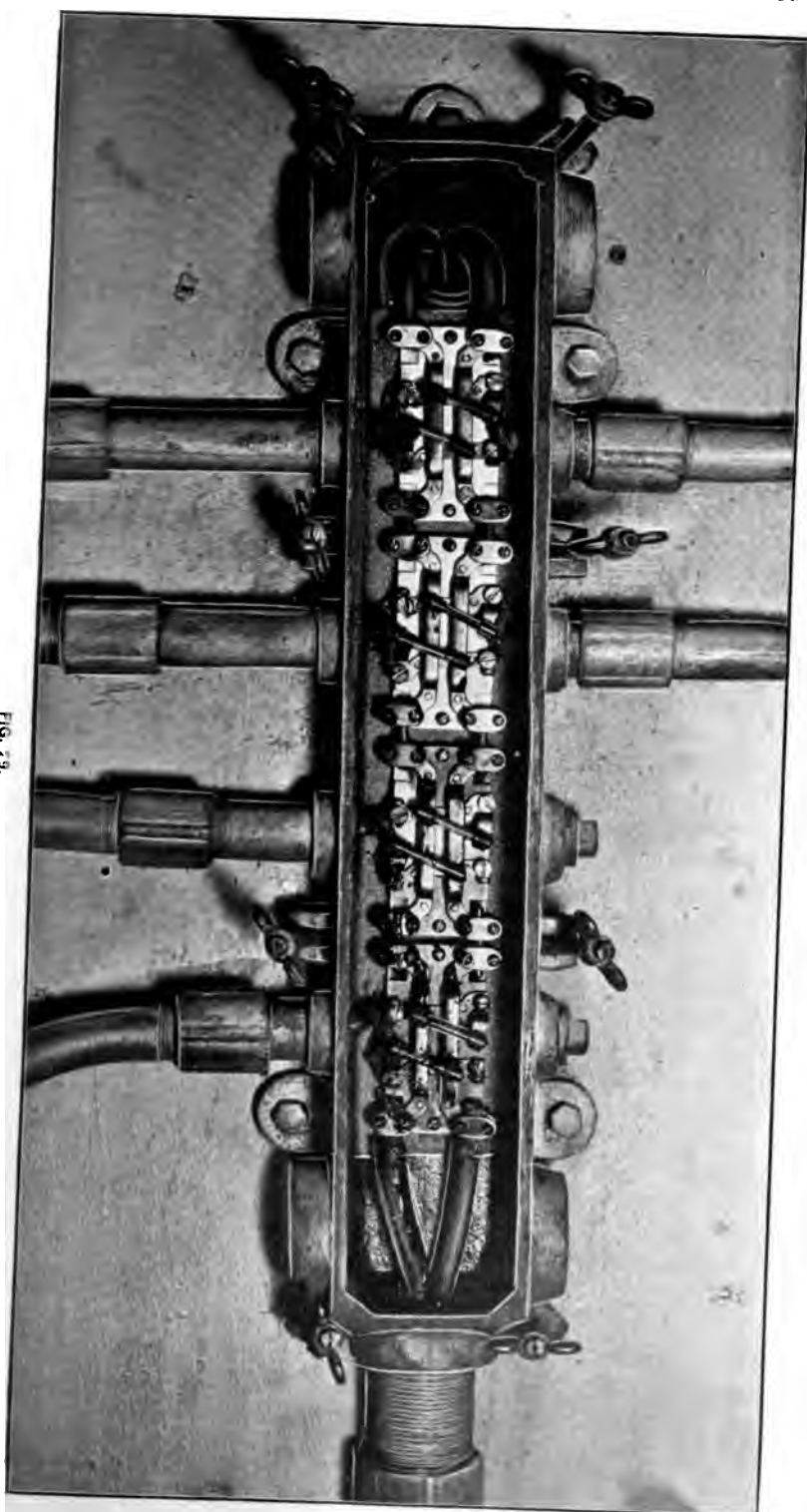


FIG. 29.

Distribution Box from Fireroom of the Puritan.

authorized persons, but the screws of the cover should be set up occasionally to ensure close fit on the rubber washers; the difficulties occur mostly in fire-rooms. Engine and fire rooms are the most difficult to install satisfactorily, and require a good share of attention afterwards.

Fig. 29 shows a distribution box and the method of leading conduit as installed in the fire room of the Puritan. The box is of cast-iron, in which are placed as many of the ordinary interior fittings of junction boxes as may be required for the branches. Bosses are cast at convenient intervals, and those bosses alone are tapped which are to be used for the leads; the branch for a single light would be run in one pipe with double conductor, plain (formerly hemp portable—the term portable is now used for its proper signification of something to be carried).

"Lighting circuits will comprise the following divisions, according to the service required." . . .

These divisions may at first seem complex, but there are really but three sets of feeders, continual service, battle service, and general service, each with its especial variety of lights on mains led off from the feeders or on submains run from the mains themselves. The chief idea is to obtain control of a large number of lights at one point and do away with the endless number of individual switches. Of all our appliances the switch is the most unsatisfactory; the insulating blocks on the stems are readily broken by thoughtlessly turning against the sun instead of with it; the contacts oxidize, heat or are indifferent in action from tension of the springs, thus introducing uncontrollable resistance.

Switches on a battle circuit are undesirable; such circuits should be handled directly from the switchboard to prevent unauthorized lights; the switch and receptacles of the light boxes and a key socket in the armory are all that can be needed. As usually installed heretofore individual switches have been a necessity, but in future installations of battle circuits none should be allowed. The mains for fire and engine room circuits are thrown on through the interconnections.*

* Inquiry has been frequently made for an answer to the examination question, "What is a balanced circuit?"

The technical term of the authorities refers to a balance of resistance as in the Wheatstone bridge, or else to a mere question of polarity, neither of which fits the case. The expression has apparently been coined in the service to mean a circuit which is connected at one or more points to

It is intended that when a loop main is run off there shall be but one loop, the submains to be run off with branches to the lights; the loop-on-loop method involves too many connections when searching for a fault or ground.

The advantage of the loop is shown in Fig. 30. If a set of lights are fed on a main as shown, the farthest lights *B* will not

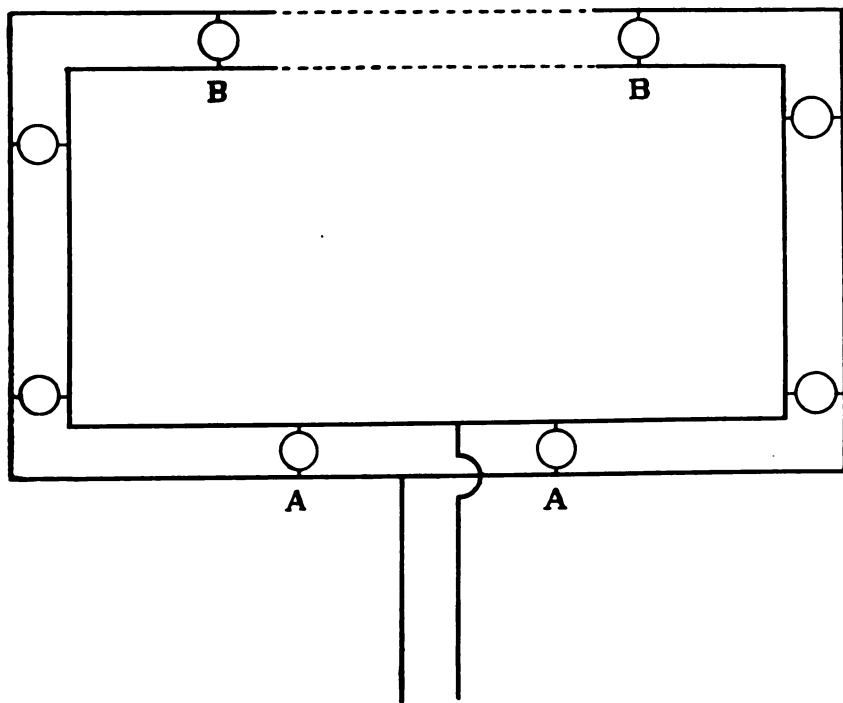


FIG. 30.

burn as brightly as those marked *A* on account of the drop (fall of potential) due to the resistance of the main. If, however, two pieces of wire, as shown by the dotted lines, are connected in, the drop will be equalized all around the "loop" and all the lights will burn with practically the same brilliancy.

The method requires a little more wire than a straight lead another circuit in order that in case of a break (from shot or otherwise) it will be fed by that other.

Balance as expressed in the question is probably synonymous with interconnection, the present term.

with lateral branches, but in a large crew-space, especially where submains are necessary, the benefits overreach the small additional expense.

"The maximum load for all lighting feeders, excepting those for search lights, shall not exceed 75 amperes. In case the current required for any service exceeds 75 amperes, a sufficient number of separate feeders shall be provided. . . . Motors below 4 K. W. will be supplied by the same feeders, the maximum load on any one feeder not to exceed 75 amperes. . . . No feeder or main will have a less area of cross-section than 1000 circular mils per ampere at the normal load, to be reckoned at the rate of nine-tenths ampere per lamp of 16 candle power. . . . Feeders which interconnect shall have an area of not less than 1500 circular mils per ampere at the normal load. . . . Not more than two feeders shall ever be interconnected, and no feeders shall be interconnected through their mains. . . .

The area of cross-section of the feeders and mains on the *lighting circuits* shall be such that the fall of potential from the dynamo terminals to the *most distant outlet* shall not be more than 3 per cent." (2.4 volts) "at the normal load of the feeder. . . . The area of cross-section of the feeders on circuits for *motors of and above 4 K. W.* shall be such that the fall in potential from the dynamo to the motor terminals shall not be more than 5 per cent." (4 volts for 80-volt circuits, 8 for 160-volt) "at the normal load of the feeder; for other motor feeders to be as prescribed for lighting feeders."

These rules have been revised, and are derived from experience in the great irregularity and want of system in wire sizes and are intended:

1. While limiting the increasing number of feeders by the large load permitted, to regulate the sizes in different ships and still provide a convenient number of circuits for the total load.

2. While allowing full carrying capacity by a stipulation of the number of circular mils per ampere, to prevent wires of undue size, weight and cost from being used by a per cent. allowance for drop. This drop, or fall of potential, is due to the resistance of the lead and is, numerically,

$$\text{Drop} = CR,$$

in which C is the current carried by the lead and R is the resistance of the lead or section of the line.

3. To prescribe a minimum carrying capacity for interconnections, which has heretofore been more or less disregarded and, in many cases, made through mains whose capacity was much too small, considering the fact that the load of both feeders must be provided for.

The general method of determining wire size has been published before, but will be briefly explained here.

The lights, outlets, etc., are first located and preliminary drawings made for tracing the feeders and mains. In large spaces lighting is based on an allowance of one 16 C. P. lamp for a floor space of one hundred (100) square feet; other spaces are lighted as deemed necessary for their use or for convenience.

The feeder sizes can then be directly calculated on the allowance of nine-tenths ampere per lamp—900 circular mils; a 75-ampere feeder can thus carry about 83 outlets, that is, provided the most distant outlet is not farther from the dynamo terminals than 111 feet.

The general formula for the area of a wire, for any distance, is

$$\text{Circular Mils (C. M.)} = \frac{2D \times C \times 10.83}{d},$$

in which $2D$ is the total length of the wire (both positive and negative legs), C is the current to be carried and reckoned at nine-tenths ampere per lamp, a margin of $1\frac{1}{4}$ per cent. on the actual necessary current, and d is the drop in volts. The formula is derived as follows:

The resistance of a conductor varies directly as the length and inversely as the cross-sectional area (in circular mils by our notation), and is equal to,

$$R = \frac{L \times s}{C. M.}.$$

L = Length of wire or twice the distance to be run.

s = specific resistance of the conductor, *i. e.*, resistance of a square inch or square centimetre at unit length at 32° F.

s , for pure copper, is 9.612, and 10.83 at 70° F., allowing 4 per cent. for twist of the strand in the length (properly a correction of L).

Now $d = CR$, from Ohm's law.

Substituting we get the general formula given. If in this formula C is unity and C. M. is 1000, $2D$ becomes 111, that is, the

longest feeder line possible at the allowance of 1000 circular mils per ampere is 111 feet; for greater distances the area must be calculated by the formula.

Wiring charts are made up for different values of the variables, from which the necessary size can at once be picked out and that size taken from the standard table which best corresponds.

In order to obtain circularity of section a strand must contain a certain number of wires of the so-called "geometrical series," that is, it must be laid with 1, 7, 19, 37, 61, 91, 127, etc. ($1+6+2 \times 6+3 \times 6+4 \times 6+5 \times 6 \dots$) of the unit wires of convenient size; this is exemplified in the table of standard wires of the specifications.

These wires increase in cost and weight in more rapid proportion than the size, and for that reason a percentage of drop is allowed to keep the size at a safe minimum.

An example of improper wire size is taken from one of our ships in the case of an 8-H. P. motor; the permissible drop at the time was 3 per cent.

The wire size used for this motor was about 350,000 circular mils.

Assuming that 8 H. P. (6 K. W.) was developed by the motor, and the efficiency on terminal energy was 20 per cent., also that the distance was 150 feet, we obtain a wire size of 136,000 circular mils for which the 125,000 standard wire (124,928 actual) would suffice. The size used is then nearly three times as large as it need be, with proportionate great weight and cost. The discrepancy is accounted for apparently by the fact that no drop was allowed for.

Our allowance of 1000 C. M. per ampere provides a large margin; the requirements of underwriters' specifications average about 725. "No tapering to be permitted."

The Tree system of wiring was quite popular at the time some of our former installations were put in. The general idea was to decrease the size of the leads as loads were tapped off to the mains or branches, and thus save wire. But it is an inflexible law of connections that wherever a wire size is reduced a fuse must be inserted, *i. e.*, a junction box, and most of the troubles that have occurred with the system have been from violations of this law. Besides, an overload on the lighter wires has but one result, overheating, ending in fusing or fire. The installation of

extra junction boxes, at \$5.60 apiece, brings the cost above that of the safer straight lead at the same size throughout; the fewer the breaks in a line the better.

" There shall be no soldered or other joints in feeders or mains except those made in the standard appliances."

This is to prevent piecing out leads with fag ends and remnants of wire, a too frequent practice in contract ships.

" Fuses for branch junction boxes to be for the normal rated load of 4 amperes, and to blow at 8 amperes."

This specifies the protection to be afforded to branch circuits, and is the basis of construction of the familiar glass tube fuses.

The proper fusing of circuits is more sinned against on board ship than any other repair which is attempted; as long as the original supply of glass tube fuses holds out there is no need for further expedient than merely replacing. When this supply fails those tubes in which the glass has not been cracked by the heat can be made as good as new by putting in a piece of fuse wire from spare stock, being careful to *securely solder* the wire to the brass caps; as practised, the wire is bent over the ends of the caps and no solder is used; the fuse is put in the clips, trusting to the pressure of the clips, vibration shakes it loose and the lights on the branch go out because there is either no connection or that the fuse has blown, owing to the vibratory contact.

When the unfused tubes run short recourse must be had to fuse wire alone, readily accomplished by running one length of fuse wire across and expending the end around the clips. A common, erroneous practice has been to run *several* turns in the figure-of-eight fashion across, thus adding to the carrying capacity of the total fuse with every run; presuming two complete turns to have been made, a reasonable assumption, there would be four runs of wire and the fuse would not blow under 30 amperes instead of at 8, as good protection to the circuit demands.

The use of iron nails for fuses, or rather as a connection, is common in fire-rooms; it usually results in fusing of the clips.

The latest fuse device taken from a ship consists of an ordinary match about which eight turns of fuse wire were wound kite-string fashion; this fuse could scarcely have blown under 60 amperes.

(To be concluded in No. 87.)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SOME ASPECTS OF NAVAL ADMINISTRATION IN
WAR, WITH ITS ATTENDANT BE-
LONGINGS OF PEACE.*

By REAR-ADMIRAL G. E. BELKNAP, U. S. N.

Mr. President and Gentlemen of the College:

I appear before you this morning, by request, to read a paper on the subject of "Naval Administration in Time of War," a subject difficult to handle, from the fact that its fullest consideration would perhaps imply a too free discussion at this official place of Department conclusions, methods, and orderings; and if, at times, I seem to stray outside the topic proposed, I but bespeak the indulgence given the parson when he wanders away from his text.

Precisely what interpretation to put on the phrase "Naval Administration in Time of War," is an open question. Wherefore I beg that I may change the wording of the topic considered to this—"Some Aspects of Naval Administration in War, with its Attendant Belongings of Peace"; for this paper will be discursive, historic, and reminiscent, rather than pertaining to departmental methods and the administrative incidents of ships and fleets.

The very able and instructive paper on naval administration—read before the Naval Institute, at Annapolis, in 1888, by Admiral Luce—is doubtless on the shelves of the college library, a work of such thoroughness and grasp that it would be a matter of supererogation to go over the same ground again. And if, in this paper, I seem to differ on one or two points from the conclusions

* Lecture delivered at U. S. Naval War College, July 30, 1897.

of my distinguished friend, the founder and first president of this institution, he will, I am sure, receive with indulgence such differences frankly expressed.

Let me premise here that the bedrock of a naval service is organization; its soul, honor; its necessity, subordination; its demand, courage; its inspiration, love of country; its crown, honor. Wise administration blends all these into one harmonious whole, and makes it an arm of the national defense, superb in its ideal, chivalric in devotion, and invincible in endeavor. To what extent our naval organization and the administration of its affairs have attained to such excellence must be determined by our own conceptions and experiences, present needs and conditions, and by what has gone before.

We are inclined, in our individual lives and personal affairs, to look upon our own geese as all swans, but when, as service men and free-handed critics, we look about us and abroad, contrasting the admiralty doings of other peoples, we are prone to think that other nations possess the swans of naval administration and excellence, while we at times but gather in the geese. Yet if we read the chronicles and histories of the past, whether pertaining to our own or foreign services, do we not find, on the whole, that in naval administration the mistakes and shortcomings of the modern naval world can by no means be all laid at our doors?

We are apt, indeed, to look upon the British Admiralty, its constitution and management, as being superior to the organization of our Navy Department and its systems of administration, but when we carefully consider the different conditions of national environment and political aim that demand our attention, do we not generally conclude that each country best understands the genius of its own people, and in every phase of naval organization and effort adapts itself accordingly?

In a certain sense it is not far-fetched to regard Great Britain as the one power whose commercial supremacy and sea-demand require that the work of her admiralty shall at all times be on lines of substantial naval administration in time of war. In such light, if we but keep our eyes open, we may draw, to our instruction and advantage, lessons of both success and failure. Nor may we forget that the prejudices and political bent of our people look askant at all forecasts of naval administration in the light of war being imminent or actually upon us.

A body of your professional knowledge hardly needs to be reminded that Great Britain maintains two great fleets in European waters—those of the Channel and the Mediterranean—fitted and equipped in all respects, or supposed to be, for instant battle service in whatever waters required. Those fleets, made up of battleships, protected cruisers, torpedo boat destroyers, torpedo boats, gunboats, swift dispatch vessels, and transports, form the basis of England's sea power; and the aim of her admiralty, not always effective, is to hold them at every moment of time up to the standard of readiness and fighting efficiency, without relaxation of effort in anywise.

In addition to these fleets, you will recollect that in January, 1896, a squadron composed of two battleships, four cruisers, and six torpedo boat destroyers, was suddenly commissioned for special service under the command of Rear-Admiral Dale. That squadron was mobilized and made ready for sea—or reported to be ready, if my memory serves me right—in six days. The British people, with pardonable glow, took great pride in such trumpeted, such intended dramatic achievement, while the press of the "tight little island" vaunted with natural exaggeration such significant demonstration of England's readiness for grim work at sea. The date of such incident of naval alertness corresponded with England's flame of exasperation at the tenor of Mr. Cleveland's pregnant message to Congress, a few days before, with regard to the Monroe Doctrine and its application, not only to Venezuela, but to all the states in general on this continent.

When telegraphic announcement was made of the hurried commissioning of that squadron, a reporter of a Boston newspaper called at my home and begged to know what I thought the assemblage of the squadron meant, and its destination. I replied that, in view of England's anger at the President's message, such special naval demonstration was possibly intended as a threat against the United States, or as a notice to Kaiser William—the Queen's British-hating grandson—to keep his hands off from the complications in the Transvaal; but if the squadron sailed under sealed orders, I would not be at all surprised if it was next heard from at Bermuda.

Within forty-eight hours after the publication of such expression I received an anonymous letter from Philadelphia, couched in very bitter language, asking how I could know anything about

the purposes of that squadron and its destination when Admiral Dale himself did not know.

No reply could be made, of course, to a person who was not man enough to avow his name or address; but Whittaker, good British authority, tells us in his almanac for this year that the chief naval event of 1896 was the "sudden commissioning in January, when difficulties appeared to be imminent with Germany and the United States, of a particular service squadron under the command of Rear-Admiral Dale." Hazell's *Annual* gives substantially the same reason for England's action.

My purpose in recalling to your recollection such naval movement is to bring before you, with unmistakable emphasis, the fact that the particular service squadron, intended by its dramatic assemblage to impress the United States and Germany—as well as the rest of the world—with England's might of preparation and elastic facility for instant mobilization of her fleets, was really in no condition of trustworthiness and efficiency to proceed abroad for war service; for, as the days went by, it was found that ship after ship needed dockyard resort and extensive dockyard treatment, before they could be regarded as in fit condition of equipment and repair to proceed on any prolonged service whatever. Such showing, slowly revealed, called forth pungent criticisms of some of the service papers of England, and doubtless bred smiles and grimaces in the cabinets of Paris, Berlin, and St. Petersburg. It is needless to add that such spectacular squadron never sailed: England, after a brief space of disgruntlement and threat, calmed down; the ships were dispersed in different directions, when they had been made really effective, and Admiral Dale was ordered to haul down his flag and come on shore.

It is pertinent here to cite the further fact that the annual manœuvres of the British Channel fleet in home waters, skilfully and ably conducted as they have been, under conditions as closely akin to the demands of war as possible, have disclosed faults of design and construction, of communication and supply, of seaworthiness and of handling, which England's great naval expenditure, the untiring efforts of her well-organized admiralty, and the undoubted experience and ability of her sea officers have not, as yet, been able to overcome or eliminate.

The lesson we may gather from such showing is that naval

constructors, marine engineers, and sea officers of inventive bent, may conceive hulls, design machinery, and father appliances, which in accordance with the rules of mathematical formulæ, promising curves, metacentric heights, and mechanical dogma, may seem to them perfect and therefore incontrovertibly correct; but that the ocean, with its fickle moods, varying conditions, and ruthless tests of sudden gales and blasting seas, but too often tosses aside, with nature's scorn, the conceptions and deductions of men, which in mold-loft and shipyard, in drafting room and machine-shop, in club and cabin, look so fair and promising.

It is a trite saying in the service that "you never know a man until you sail with him." So, too, despite oft-mistaken theory, mathematical demonstration, and professional observation, you never know what a ship will do at sea until old Neptune has plied his buffeting hand and given the verdict of his finding as to her qualities, and the seal of his approval or disapproval as to her merits or demerits.

I am reminded here of the story of the Pawnee, which vessel did such excellent service in inland waters in rebellion days. She was built during the closing years of Mr. Buchanan's administration. Mr. Griffith, her designer and contractor, had proved to his own satisfaction, by mathematical formulæ and shipbuilding experience, that with her double bilges, like the rear of the commandant's house at Boston Navy Yard, great beam and light draft, she would make the steadiest gun platform ever devised for sea use; that her motion would be so slight, so easy and steady, that the veriest landlubber who ever paid tribute to old ocean could never get seasick on board her.

The Department, impressed by his ideas, and possibly with an eye to political effect, allowed Mr. Griffith to build the ship, under the provisions of law and contract. In due course she was ready for her trial trip. With light heart and unabated confidence, Mr. Griffith embarked, to demonstrate his conquest of the vagaries of the sea, as conceived in the dreams of his shipbuilding soul and embodied in the Pawnee's double bilges. Commodore Pendegrast, the commandant of the Navy Yard, Philadelphia, a distinguished officer of his day, accompanied him, as well as the naval constructor at that station, and other personages not altogether ignorant of salt-water surprises. All went merry as a marriage-bell while going down the Delaware, but no

sooner had the ship got outside the capes than a gale of wind overtook her, and before the party on board could fully take in the fact, a heavy ground-swell sea was making, which in a twinkling threw the designer and cannot-roll theorist, Mr. Griffith, into the lee scuppers, which he was but too glad to seek, for nameless relief. The naval constructor fared no better, and even the salt-seasoned old commodore and veteran petty officers and seamen had to acknowledge that their legs and stomachs had never encountered such astonishing tests before. The launch, secured on deck amidships, was torn from her lashings and hurled from her cradle by the quick, violent motion and jerky rolling of the ship, and everything movable was tossed and thrashed about in the same exceptional way.

When I entered the service in 1847, the naval elephant in evidence and supreme demonstration of the fallacy of theory alone was the steamer *Alleghany*. She was an iron paddle-wheel vessel, built on the designs and under the supervision of Commander William T. Hunter of the Navy. Her paddle-wheels were fitted horizontally into recesses of the ship's hull below the water line. Hunter's idea was to protect the wheels from the enemy's shots, but the backwater in the confined recesses and the boring effect of the shafts upon the lower bearings made short work of his theory. Hardly more than five knots could be got out of the vessel under average conditions, and constant repairs of lower shaft bearing were necessary. After continued experiment, at great expense, she was converted into a receiving ship at Baltimore.

Fourteen years later, under the demands of administrative and service need in time of war, Chief Constructor Lenthall, the ablest naval constructor of his day in our service, affirmed that the Monitor class of vessels, designed and submitted by Mr. Ericsson, was an absurdity and would not float. The tests of sea and battle under grimmest conditions made Mr. Lenthall acknowledge that his pronouncement had been wrong. His conversion, indeed, from his original decision against the Monitor type was so frank and complete that the *Monadnock*, built on plans and lines of his sanction by Constructor Wm. L. Hanscom, proved to be the best vessel of her class constructed during the war or since. In battle her superior merit was clearly shown; in peace, her voyage from the Atlantic to the Pacific, through

the Straits of Magellan to San Francisco, attested beyond question her prime seagoing qualities—qualities that cannot be successfully challenged at this day. And let it be noted that no abomination in the form of superstructures blocked sweeping seas and burdened her deck.

On the other hand, Captain Coles of the British Navy, who had designed and supervised the construction of the ill-fated Captain, in face of admiralty disapproval but by Parliamentary consent, went down in the ship, giving his life in that tragic way to a theory of construction his fellows had condemned.

But you may ask what has all this to do with naval administration in time of war? My answer is that the Navy Department was organized for war; that it can never divest itself of that quality; that whatever it does, the possibilities and contingencies of war are, and must ever be, its prime concern; that the work of peace is but preparation for war in its every phase and incident; that to know this to best advantage is to be informed as to the mistakes of the past, and to act accordingly.

This naval station, which comprises within its limits and control the three institutions of the Training Station for apprentices, the Torpedo School and Station, and the War College, is a significant illustration of war effort. The Government has not only educated the officers in command and in attendance here to the art of war as it must be practiced on the sea, but it has sent you here to enlarge and perfect your education on special and technical lines, which the continued discoveries of science, the genius of invention, the restless activity of the age in every direction of enterprise and endeavor, and the rivalry and determination of the naval powers to grasp and possess the completest and best of the destructive constructions and appliances that the brain of man devises for war's dire work, make necessary for you to know and enable you to meet.

Nor need I remind you that every vessel of war we send abroad to defend our flag and to represent the dignity of the nation on the high seas or in foreign ports carries within her stout hull and the strong hearts of her officers and men the means and ultimatum of war, for exercise and showing whenever occasion may make demand for them. If they do not, then the money the country has expended on them has been expended in vain, and naval administration has been sorely at fault. There

can be no better maxim, indeed, as to naval policy than this: administer department affairs as though engaged in war. Not indeed on the scale demanded by actually present hostilities, but in scope and conduct vital to thorough preparation and undoubted efficiency—to the avoidance of the hurly-burly and waste that war bursting unexpectedly upon a country invariably engenders. In brief, to so administer naval affairs in peace that simple expansion of organization and method will alone be necessary to meet the conditions imposed at the first tap of war's dread drum. But we know that with us such policy is almost impossible, for under our form of government and its ramifications of political power many constituencies and special interests bitterly oppose all expenditures for naval and military purposes; and, from the conditions and outlook of a score of years ago, the wonder is that we now stand as well as we do as a naval power. On the other hand, if we look with straight-eyed candor and in the spirit of judicial examination into departmental management during the past one hundred years—which practically covers our naval life as a nation—and the results that have been achieved, we cannot but admire the general administration of affairs that has brought so much prestige to the country and such splendid illumination of the flag, which it is your rare fortune to continue to bear abroad as its custodian on the sea and as the staunchest defenders of its honor. But do not forget that such administrative effort was made possible by the splendid work of the matchless seamen who have gone before us.

When we reflect that our system of education, training, and administration has given to the age a Mahan, who by his histories, begun at this college as a series of lectures, has so profoundly impressed the world, and especially Great Britain, as to the supreme influence of sea power as a determining factor in the relations of the maritime powers toward one another, we may well say that in certain aspects we are content. To-day Mahan's name and the story of England's achievements on the sea, so strikingly set forth by his able pen and brilliant scholarship, are more potent in the British Parliament for naval chieftains to conjure with, in support of measures to increase the dominance of the British Navy, than the voice and arguments of any living Englishman. I do not know, indeed, but that our distinguished fellow-alumnus of Annapolis should be court-mar-

tialled for furnishing such aid and comfort to our English cousins in their effort to maintain their supremacy on the sea—a supremacy that we must always regret and which we should always resent.

I wonder what the amiable Cockburn, who in 1814, as a British admiral, took the Speaker's chair at the National Capitol, and after putting the question, "Shall this snug harbor of democracy be destroyed?" gleefully ordered the torch to be applied—would have said could he have foreseen that, before the century closed, the dictum of a Yankee naval captain, as regards the British Navy, would be so eagerly listened to and so closely followed. It is, indeed, a happy fact that democracy has bred on this soil neither an Admiral Cockburn nor a Hudson Lowe, both of infamous memory. England is quite welcome to men of that sort—the products of her naval and military training and administrative methods, which of old were akin to mercilessness.

No graver problems of difficulty and discouragement ever confronted the naval administration of any nation than our Navy Department had to meet in the early days of 1861, when, after a rudderless drifting of some four months toward the rapids of destruction, the country found itself involved in civil war. Up to that period the organization and administration of the Department had been of the simplest character. Its personnel was mostly civilian. Aside from the then five chiefs of bureau, three of them of the line, standing for the military branch, there were hardly more than half a dozen other officers on duty in the various offices. The office of detail was unknown. The Secretary and the chief clerk attended personally to all matters concerning the personnel of the service, the selection of the officers for their varied duties afloat and ashore, and conducted the chief correspondence pertaining thereto. Nor did the incessant demand of the war, and the overwhelming work it imposed seven days in the week, and often throughout the nights, during four long years, seem to make it necessary to increase, to any marked extent, the purely naval branch of the Secretary's staff. True, the office of detail was established, and the office of Assistant Secretary created the moment it was seen that great naval expansion would be imperative, for effective operations against the insurgents, and, possibly, against a foreign foe. In July, 1862, the Bureaus of Navigation, of Equipment and Re-

cruiting, and of Steam Engineering, established by Congress, took from the other bureaus created twenty years before, some of their powers and duties, but such additional division and ramification of administration did not much increase the personnel of the Department, especially as regarded the officers of the service, whether of line or staff.

Now, when we consider the task of the Department in 1861, the obstacles it had to overcome, the work it had to do, and the results it achieved, it must be admitted, I think, that on the whole our naval administration during the four eventful and remorseless years that followed could hardly have been bettered. And in such light, such showing, we may well take lessons for future administrative work in time of war.

But let us not forget how fortunate it was for the service and the country that the Secretary of the Navy at that momentous period was, as a former chief of bureau, not unfamiliar with naval affairs and had large acquaintance with navy men; that the Assistant Secretary, who had resigned his naval commission a few years before to take up civil pursuits, was thoroughly cognizant of service thought and nautical possibilities, as well as the standing and temperament, idiosyncrasies and limitations of his old associates, which, together with the equal knowledge possessed by the detail officer—now for the first time recognized as a necessity and clothed with authority—made it easy, and generally without mistake, to select officers for assignment to the duties they were deemed best fitted to perform, whether in command of fleets or ships, or on other service of whatever character.

In the midst of the most stressful period of the war, old officers of the Navy said to Mr. Welles, "Why don't you relieve yourself of some of these killing details of work and organize a board with powers akin to those of the British Admiralty?" "No," said Mr. Welles, "the law and the confidence of the President make me responsible. Members of boards form conflicting opinions and sometimes block action. Such system would not do for us, especially at this juncture. I am open to fact and argument. When all are laid before me, I can on the instant consider carefully and decide intelligently, and be prepared to justify my action." The Secretary was right. Commissions and boards are a snare. In great executive spheres and posi-

tions of prime responsibility, particularly in naval or military affairs, the one-man power, under the law, is necessary, if we would have efficient working and desired results. Three captains of a ship would make short and destructive work of discipline and purpose, though in these leveling days, tending toward insubordination, much in that line is suggested and sometimes attempted.

Said General Logan, in reminiscent talk of incidents of his service in the field: "General Grant would call a council of war, listen silently in bent, contemplative mood to all we had to say, and then dismiss the council without having said a word as to what he intended to do. The first intimation we would get of his decision would be embodied in orders for our execution, as likely as not to be in utter variance with the opinions we had expressed. We didn't like it altogether, but we knew we must obey."

So, too, Farragut, when he called his captains together before his first brilliant work on the lower Mississippi, and a captain rose from his chair to depict the difficulties of the proposed operations and to advise against them, the dauntless old Viking broke in with these words, "Gentlemen, I have not invited you here to consult you as to the feasibility of the proposed attack and passage of the forts. My mind is made up on that head and the attack will be made; any suggestions you can make as to the best means of forwarding that movement will be gladly received; I can entertain none other." Ah! that is the sort of men we want Annapolis and Newport to turn out. A man who knows his own mind, has the courage of his convictions, believes in himself, and in the loyalty, devotion, and intrepidity of the officers and men he commands under any circumstances of peace or war. An officer whom to know is to love, whose subordinates, in their great trust and supreme devotion, will follow to the death!

I must confess my regret that, in his lectures here, Mahan did not draw more upon the incidents of naval valor and achievement from the history of his own country. Strategic movements upon land and the controlling efforts of fleets on the sea are, in my judgment, utterly and entirely indifferent. And, as an American, grateful to France for what she did for us in the Revolution, I wish that Nelson might have met at Trafalgar—not a Villeneuve, with his hesitating Spanish ally, his half-hearted

captains and seasick crews, but an officer of Farragut's dash and determination, supported by such able and intrepid captains and officers and battle-seasoned seamen and marines, whose valorous work in gulf, bay and river, led by our great admiral, make such glowing pages in our naval annals. Those gallant souls would have counted it a great joy to meet British seamen under like circumstances and show them the difference between Gallic and Yankee webfoots.

When the Southern politicians engineered their schemes for breaking up the Union they took but small account of the Navy, what it could do in the event of hostilities. Nor did the Southern officers who threw up their commissions show much keener perception. They had not yet learned, after all their association, to know the fibre of their Northern brothers, and what an aroused people, full of the instincts of the sea, could do when confronted by a great emergency. For three months after the tide of secession had set in, our officers and men serving abroad did not know from week to week whether they had any longer a government. The country had but forty-two ships of war in commission of all rates, and all having among the officers—never among the seamen—some who meant to throw up their commissions the moment they could do so. Officers at home—both of the Navy and Army—were sending in their resignations and hurrying South from day to day, while timid souls, weak-kneed politicians, and other frightened folk, losing their heads, begged for a policy that would save the land from bloodshed—even to the acknowledgment of the Confederacy. Meanwhile, British statesmen of the Palmerston and Russell type not only laughed in their sleeves, but openly sneered at the day of Yankee discomfiture and the death-stroke to the Great Republic which had come, as they thought, and they felt happy. The press magnates and magazine seers of England took up the notes of jubilation, and soon, with great satisfaction to themselves, blotted us out as a nation and established from three to five confederacies out of the territory of the United States. But the echoes of Moultrie's guns and the reverberations of Sumter's reply had hardly died away before the entire North sprang up as if possessed with one soul, and said "This thing shall not be!" Across the seas and continents flashed the tidings, stirring the world with sensations it had not known since the outbreak of the French

Revolution. Our citizens abroad dropped their business and hurried homeward to do their duty in defense of the flag, and, swelling the tide of patriotic ardor, came hastening from every sea the officers and men from our then incomparable merchant marine, eager for navy training and service afloat against the enemy.

Then came a great triumph for our system of naval administration—its elasticity for preparation in emergency and its effectiveness for war. Mr. Secretary Welles at once called about him some of the ablest and most experienced officers of the day to consider the situation, formulate a policy, indicate plans of operation, and fix upon the best and speediest means for the building of new ships, the purchase of merchant vessels and their conversion into cruisers and blockaders, the recruitment of officers and men and the means for their training, and the many other incidents of service needs and details of supply that naval operations in war would require.

Those matters duly considered and determined upon, the officers consulted were dispersed to different points to carry out, with the aid of eminent persons in civil life, the measures agreed upon. Under such illumination of purpose and with masterful grasp of the difficulties to be overcome, and an energy and versatility of effort and direction never surpassed in the world's greatest epochs, the little navy, despite the temporary demoralization it had suffered through the desertion of many of its ablest officers, was soon expanded into a great service of frigates and ironclads, heavy and light sloops-of-war, gunboats and supply vessels, of more than six hundred pennants, and a personnel of some seventy thousand officers and men. The officers and men who had volunteered from the merchant service, trained to the habits of the sea, soon became, under special instruction and drill at schools established at the navy yards and stations, and through service afloat, staunch men-of-war's men—who were heard from, to their great credit and valiant bearing, in every naval battle of the war, as well as in the burdensome, harassing duties of the blockade, and every other incident of service belonging to seamen.

Four squadrons or fleets were mobilized in briefest time, and the extended blockade from the Chesapeake to the Rio Grande was established, before Earl Russell had grasped the fact that

no paper blockade had ever been contemplated on this side of the water, of which alone he thought the United States capable.

Fast supply steamers of great capacity were fitted out to traverse the lines of blockade and distribute fresh provisions and other supplies to the ships, convey officers and men, including the sick and wounded and prisoners, back and forth, and to carry mails and dispatches. Sailing on fixed dates from Philadelphia and New York, their service was performed with the regularity of the transatlantic packet service of this time. And when good lodgment had been made on the insurgent coasts where permanent squadron headquarters could be established, the floating machine shop, the receiving and hospital ship, the collier and ammunition supply vessels speedily followed. And, in short, every essential of supply and equipment was furnished with a marvelous foresight and ready facility never surpassed by any naval power.

Would you know more fully what such accomplishment meant, contrast the pitiful showing made by the fleet England commissioned and sent to the Baltic in 1854 at the beginning of the Crimean war. The state of the British navy and the administration of its admiralty were so low and inefficient at that day that the fleet, consisting of fifteen vessels—battleships, frigates, and paddle steamers—was hurried off, incompletely manned by crews so raw and undisciplined as to be almost non-descript. One ship, the *Monarch*, when reinforcements were to be dispatched, was detained some time because of the mean character of the crew. It was reported, indeed, that “scarce a man on board knew a rope.” In all the ships the lack of trained petty officers and men-of-war’s men was distressing to those in command, with the responsibilities before them.

When the commander-in-chief, Admiral Sir Charles Napier, complained of such conditions, he was told to fill up his meagre, untrained complements by picking up Swedes, Danes and Norwegians on his way to the scene of action. The attempt to draw men and second and third mates from English merchantmen, to make petty officers, failed utterly. Volunteering to meet an enemy in time of war was an instinct of patriotism unknown to them. Not one officer from England’s merchant marine would consent to serve unless assured of permanent place in the Royal Navy. How different the spirit and actions of the men and

officers of our merchant marine in 1861, as already noted. The admiral asking for gunboats and small steamers, for operations in the shoal waters of Cronstadt and other points in the Baltic, was instructed to negotiate with the King of Sweden for the use of his gunboat fleet, and also to be allowed, as a matter of economy, to hire small steamers of Swedish subjects for operations against the enemy; but the King was too wary to put his foot into so clumsy a trap, which would have made him an ally of England and an object of Russia's resentment, to be reckoned with sooner or later. Equally futile was the admiral's effort to make up his shortness of junior officers by the hiring of Swedish officers to serve in his fleet at that juncture. What would have been said of us, indeed, had our naval administration been so inefficient as to have obliged us to attempt to hire foreign officers to officer our ships in rebellion days? What scathing criticisms would have come from John Bull!

Most surprising was it too, when regarding it as absolutely indispensable to exercise his raw crews at target practice, the admiral was cautioned to "be careful in such expenditure of ammunition, because the supply of powder and shot at home was so limited." And this on the occasion of England's last great war with a naval power. Such grave instance of maladministration seems almost incredible, when we know how perfect in every detail and ample in supply was our ammunition under the urgent demands of the war we were called upon to wage so suddenly a generation ago.

It is needless to add that this expedition, so much heralded at the outset, failed most lamentably in its object; but when we read Admiral Napier's biography and letters we must conclude, I think, that the fault lay in the admiralty's surprising lack of apprehension, and its marked inefficiency in grappling with the problem of war and its naval needs for successful prosecution, rather than with the methods of Sir Charles. That distinguished officer, however, on his return to England from his ineffectual campaign—due in part, at least, to admiralty shortcomings—was dismissed from his command, and under such circumstances of discourtesy that another notable flag officer, to whom the fleet's command was offered, promptly refused it on the ground of Napier's treatment, and for the further reason that "he would not command a fleet in which the officers were set to criticise their

admiral." And, says Napier's biographer, "It is a singular, yet incontrovertible fact that every British admiral of eminence, when in command of a fleet, has been subject to the marked enmity and insult of the Board of Admiralty." How close to the truth such averment is, you have but to read the memoirs, letters, and biographies of England's great seamen, among whom may be cited Keppel, Lord St. Vincent, Dundonald, Hawke, Collingwood, Napier, and others, including even their great sea king Lord Nelson.

In our inherited tendency—nay, birthright as seamen—to growl, when we criticise our departmental administration, we have but to look across the water to find doings and shortcomings in naval affairs that have as yet found no place in our annals—whether for corrupt administration or vindictive motive.

Yet our British kinsmen of the sea have this advantage over us, that an officer on the active list of the Royal Navy can take his seat in the House of Lords, or be elected to the House of Commons, and stand up in his place and criticise the ministry and their administration, and denounce what he regards as admiralty shortcomings, as freely and fearlessly as any other member of Parliament, and there is no authority that can bring him to book for it, except through Parliamentary procedure. An officer like Lord Charles Beresford attacks admiralty methods whenever he feels like it, but he is very popular among the English people, and the members of Her Majesty's Government have profound respect for public opinion, especially as ugly questions put in Parliament must be answered.

In this connection, let me invite your attention to an article in the *Fortnightly Review* for July, entitled "England and the European Concert," written by Captain James N. Gambier, R. N., an article that describes in most pungent terms the shortcomings of the British ministry, in its dealings with the Cretan and other questions of vital import to the British Empire, as one of the great powers not only of Europe but of Asia.

The Queen's age alone seems to spare her from the writer's scathing criticisms, but Lord Salisbury, his temperament and methods, his indecisions and final commitments, are dealt with in the most searching, blunt-spoken, and contemptuous manner.

Were an officer of our Navy so to express himself with reference to the management of our affairs by our President and his

Cabinet, he would be speedily brought before a naval general court-martial for violation of law and regulation; but should an American officer lose his rights and privileges as an American citizen simply because he holds the commission of his Government? The Englishman under no conditions of place or station, circumstance or employment, loses his birthright, which his ancestors sturdily contended for long before the days of King John and Magna Charta—the rights of opinion and of speech—rights the violation of which led Charles I. to the block.

To return from this digression, let us note the fact that in 1856, or just two years after Sir Charles Napier had sailed for the Baltic with his somewhat Pinafore array, the ships of that fleet constituted a part of the grand naval review held at Spithead, preceding the dismemberment of the fleets that had been engaged in the Crimea and the Baltic. Neither fleet had accomplished much in their operations against the enemy, but the combined force of twenty-two battleships, forty-two frigates and corvettes, seven floating batteries, and a large number of dispatch vessels and gunboats, manned, as the *Chronicle* says, "with 50,000 sailors," made a splendid showing. Yet from what we have noted on British authority as to the quality of the crews Admiral Napier had to deal with at the outset, we may well question the assumption that the "50,000 sailors" of that occasion were seamen in the true sense, though we may not doubt that Sir Charles had "licked his crews somewhat into shape," as the phrase goes, before he left them. The cat was still in lively swing in the British service, and it was a powerful persuader.

Lately historic Spithead has seen the greatest of all its naval pageants. In truth, the smoke of the thunderous salutes, acclaiming the sixty years' reign of the Queen and the pride and power of the British Empire, has hardly yet drifted away, while the press of the civilized world has labored, and still labors, to give adequate voice to the impressions of strength and grandeur which that vast assemblage of ships, that weighty display of sea power, made upon all who had the rare fortune to witness it.

That unequaled display of nearly two hundred pennants, streaming from the mastheads—if masthead is not now a misnomer—of battleships and armored cruisers, torpedo gunboats and torpedo-boat destroyers, and other well-equipped craft for war purposes, showed at a glance and with awesome significance

what those sturdy folk of the British Isles have accomplished in the world's great affairs, and the pardonable pride they take in impressing their great deeds and unsurpassed achievements on sea and land upon the knowledge and mind of mankind; but as British royalty and British statesmen looked upon the short line of foreign ships of war that were present to do honor to the Queen's fete and to the British nation, there must have come a sigh—a pang of bitterness—from many a British heart, when the eye fell upon the flag floating from the staff of the Brooklyn, for that flag represented the majesty of a great people who had broken away from the thralldom of colonial life and the tyranny of the British Crown, and made for themselves a weighty place among the nations; a flag that stood for the wresting of a great domain from the British Empire, and in significance of the greatest defeat in the annals of her imperial policies; a flag which, despite her great sea power, Great Britain must respect, even to the curbing of her aims and pretensions on this continent.

The modern battleship, with her pent-up powers of destruction and wondrous mobility, her intricate mechanism and surprising adaptation of the mysterious forces of steam and electricity, constitutes one of the most daring conceptions of the human brain, among the greatest conquests of man over the secrets of nature. But like God's masterpiece—man—its parts are liable to accident, derangement, and destruction.

Wherefore, when, after the dazzling display at Spithead the other day, a naval authority alleged that "in four days one hundred and twenty vessels of that fleet could be at Gibraltar; that in nine days the Channel fleet, twenty-nine strong, could be at Halifax; in twenty-seven days at Delagoa Bay, and in fifty-eight days at Hong Kong," I am inclined, in the light of experience, to discredit such assumption.

Holiday showing is not to be relied upon; such displays make no test of a ship's efficiency for cruising and for war. Long ocean passages, the encounters of gale and sea, and the rollings and strainings incident thereto alone determine seaworthiness, the reliability of machinery, the stability as to platform for efficient use of the guns, character of steerage qualities and ready handling of the ship in the varied emergencies and demands of salt-water work.

Since Spithead's great demonstration, the Channel fleet has

held its annual manœuvres, and from the reports gathered from the newspapers we learn that the orders of the admiralty were not understood, and that serious accidents have caused misgivings as to the efficiency of the fleet. Among the accidents noted was the scoring of one or more of the cylinders of the battleship *Mars* and of the cruiser *Terrible*, incapacitating those ships for further present use. Such chroniclings of misunderstanding, accident, and disablement do not look like nine-day passages to *Halifax*. They point rather to inefficient management of machinery and weakness of parts. Nor do they compliment the interpretation of admiralty orders, which we should take for granted were intended to be as concise and explicit as the conditions of war and its surprises ever demand.

England, in her mighty efforts to continue her dominance of the sea, conducts these annual manœuvres on a large scale and at great expense. The mistakes she makes brace up her accomplished officers and gallant men to higher effort and more approved methods. She thus helps herself on professional lines and also instructs the world on naval needs and advancement. To profit by her experience and to note her mistakes with careful heed has even been the wise policy of our naval administration, whether in peace or war. Wherefore, what has been said, I submit, has been pertinent to the subject in hand.

But I know no more instructive illustration of brilliant naval administration than Japan displayed in her recent contest with China. Her success was no accident; it was the result of long preparation and thorough organization, well matured and skilfully perfected.

From the moment Japan had fairly entered into treaty relations with the Powers, as the result of the incomparable diplomacy of Commodore Perry and Townsend Harris, and opened her ports to intercourse and trade, she began to think of a navy. And likening her geographical position in the Pacific to that of the British Isles in the Atlantic, she took for her inspiration the island wisdom of England, and set forth with pronounced energy to become a naval and commercial power. She at once established dockyards and schools of training for seamen and gunners, and every class of mechanic or artisan needed on board ships of war at this day. She also organized a naval academy at Tokio for the education of cadets, and arranged with foreign govern-

ments to have some of her youth received and trained to the naval profession at their respective technical schools; nor need you be told that among the most honored officers of Japan's navy to-day are some of your fellow-alumni of Annapolis.

When, in 1889, I first visited the imperial dockyard at Yokosuka, a few miles below Yokohama, I found, to my surprise, an establishment and plant superior in equipment and completeness to any yard we possessed at that time.

Annually, for several years before Japan threw down the gauntlet of war to her colossal neighbor, the Emperor used to assemble the flower of his army and the major part of his fleet and transports on the shores and in the waters of Owari Bay, on the southern coast of the Empire, for inspection and drill, evolution and manœuvres.

There, attended by his ministers and members of the diplomatic corps, and other distinguished personages, the Emperor would pass a week in camp and on shipboard, inspecting and reviewing, and witnessing the manœuvres and evolutions of the army and fleet, and engaging them in mimic war, pitting the one against the other in carefully prepared plans of attack and defense. The embarking and disembarking of troops, the handling of artillery and horses, pontoons and ladders, ordnance supplies and intrenching tools, provisions and hospital fittings, were among the features of the occasion; and no detail likely to be demanded by the necessities of war was omitted. *On the conclusion of such annual manœuvres, all defects disclosed were immediately remedied;* and so it came about that, before the news of the declaration of hostilities between the two great Asiatic powers had reached London and Washington by telegraph, the fleet and army of Japan were already on the move for the scene of operations.

One morning, in 1890, and within sight of the spot where Perry signed his treaty in 1854, I saw a special train from the dockyard at Yokosuka pull into the station at Yokohama, bringing the officers and crew for a new cruiser, then approaching completion at a shipyard in France. As the detachment, thoroughly homogeneous in character and dressed in the neat uniform of navy fashioning, left the train and fell into line under the direction of its officers, with an alertness of movement and readiness of execution that no other service men could have surpassed, and marched to the bund to embark upon a French steamer bound to

France, I was moved to admiration; and I wondered what Commodore Perry would have thought could he have lived to see such incident as one of the significant results of his masterly diplomacy at that historic spot, where all others before him had failed.

I have said that Japan likens herself to England. To be the England of the Pacific is her dearest aim. She is pushing and ambitious, and wishes to become a colonial as well as a naval and commercial power to be well reckoned with. She has already possessed herself of Formosa—an island magnificent in its possibilities. That she has an eye to the acquisition of the Philippine and Caroline islands, the secrets of her foreign office would probably disclose. That her probable wishes in those directions are natural no candid observer may gainsay; and what she aims to do she will not give up, except under circumstances of great stress. Her statesmen are able and accomplished. Bred to arms and of martial mien and spirit, they are discreet but fearless, energetic, farsighted, and tenacious; and so self-contained withal, that no Talleyrand or Richelieu ever surpassed them in the art of hiding in words their real intentions.

In the line of current events, you doubtless have noted what Sir William White, the eminent British naval constructor, was alleged to have said to one of the Brooklyn's officers, when dining recently in his company. "You Americans need to keep an eye on Japan; the Japanese are likely to give you trouble," was the pregnant remark of Sir William. Then allusion was made to the advanced state of the heavy battleships Fuji and Yashima, building in England for Japan's navy, and how readily they could proceed to the Pacific, if occasion demanded their immediate departure. Doubtless such hint as to their readiness for service is true, in view of the habit of the Imperial Government of dispatching officers and men in time to receive and man the ships contracted for on their completion in foreign countries; and, in my judgment, knowing Japan and her aims as well as I do, our Government will make a grave mistake if it does not give pronounced heed to what is in the air—Japan's wish to plant her flag at Hawaii.

There should be no occasion for the United States and Japan to clash in any direction, but our interests can never permit Japan or any other power to seize and hold that group of islands in the

North Pacific, destined to become the most important commercial center in that great ocean. It will be, indeed, the most stupendous blunder of modern times if we allow any other flag than our own to float in sovereignty over that gem-like possession, and the sooner our flag is planted there the better. It ought to be there now; that would settle the matter, and give the diplomatic world something else to think of. Japan's strong and earnest protest bids us beware of delay; immediate action is urgent. Were I the commander-in-chief of the Army and Navy of the United States, having before me the free and unreserved offer of the islands, and with a signed treaty in my hands, I would order the fastest steamer we have in Pacific waters to proceed to Honolulu with all dispatch, carrying orders to the minister and admiral to hoist the flag over the islands instantly. That would be a Jeffersonian or Jacksonian method, which, at heart, the American people like. It would also be a refreshing incident of administration akin to naval administration in time of war, and, quite likely, would save a vast deal of complication in future.

To turn back to the matter of our civil war, let me remark that if such tragic episode in our national life had, under the purposes of God, to come sooner or later for the settlement of the grave questions hanging upon its results, then it was well that it came at the time it did; a time when the present power and range of ordnance, the limits of armor, and the development of the automobile torpedo and swift torpedo boats were still in the womb of the future. The naval part of the long siege at Charleston could not have been maintained had the Confederates been possessed of the heavy long-range guns, the rapid firers, and the swift torpedo craft of this day.

During the progress of that siege, the ironclads, when not in action at the front, used to lie quietly well down the channel inside the bar. And further down towards Stono inlet were anchored, in positions regarded as safe from attack, the ordnance, the store vessels, and colliers. Such immunity from attack would be impossible now, in face of the newly-acquired power of the torpedo, for from personal experience, I think it safe to say that, on an average of one night in three, the waters of our southern coasts are so overborne with mists that torpedo craft of the advanced speed of to-day—25 to 30 knots—well handled, could have got in their work upon us, in rebellion days, inside Charleston bar, with fatal facility.

The demands upon the Navy in that four years' war were unique. Save the Sumter and Alabama, the Florida and Shenandoah, and a few lesser craft, the Navy had no enemy to look for on the ocean. The chief work was in fighting forts and earthworks; attacking the few ships that the insurgents had in bay, river, and harbor; establishing by capture bases of occupation along the coasts and on the Mississippi, for both the land and sea forces; co-operating with, and sometimes protecting, the army in its coast, river-side and Mississippi Valley operations; seizing and holding the great Father of Waters and its tributaries open to our movements and control, closing such strategic water communication to the use of the enemy; and the maintenance of that blockade which, for closeness, effectiveness, and pregnant results never had its equal in the world's history.

The work so outlined seems simple in statement, but it covers a vigor of administration, doggedness of purpose, splendor of valor, and brilliance of achievement never surpassed by other men of the sea, of whatever nation, in any age or period.

The conception and building of our fleets and flotillas on the Mississippi and its tributary streams is worthy of special remark; it never had its parallel in any other land, nor is it believed that any other people could have shown the aptitude, versatility, and ingenuity displayed by our people in the emergencies that called for their efforts in such unique way. It was a luminous illustration of our naval administration in time of war.

When the demand came, if my memory serves me right, the Department first sent John Rodgers, of glorious memory, to the West, to organize a naval establishment and begin the construction of suitable vessels for river service. He was given *carte blanche* to appoint officers and enlist men. When he had got construction and transportation well in hand, he was succeeded by the iron-hearted, indomitable Foote. He continued the work until compelled to retire because of a serious wound received in battle. Then followed Davis, cool, accomplished, and able. He fought and won the fleet fight at Memphis, and then yielded the command to David D. Porter, than whom as seaman, organizer, and fighter the chronicles of the ocean never knew his superior. To know what he did in those stirring days you must gather the story from the lips of his devoted officers and men, and read the memoirs of Grant and Sherman. He was our Sheridan of the sea—masterful, dashing, inspiring.

The things accomplished by the several commanders-in-chief in the lines of construction, transportation, and operation were wonderful. Steam vessels of the most nondescript character were converted, some into heavy ironclads, others to a lesser type of protected vessel known as the tinclad, while a multiplicity of smaller craft, of draft so light that they could almost float on morning dew, were fitted and equipped to penetrate the shallow creeks and inlets and show the flag in effective way to the rebel folk too retiring to be found in any other way. The salt-water sailor hitched his trousers alongside his fresh-water fellows, the pilot and steamboat man; and the comradeship of a common cause, instinct with fervid patriotism, unified their methods and traditions, and bound them together in a disciplined whole that made superb river crews and fighting material of the best sort. That was a creative and administrative feat in war from which lessons may be taken in future.

I submit the opinion that England, with all her glory of accomplishment, vast empire, and system of naval administration, could not have done so well on inland waters under like conditions; and we should bear well in mind what we did, and hand its record down to posterity, for the day may come when the flag may have to float over similar things and doings on the Amazon and the Orinoco.

In a war with a foreign power possessing a navy, entirely different conditions from those of our civil war will confront us, for which our naval administration should be prepared. It should not only be prepared, but, toward the end of thorough preparation, welcome suggestion from any intelligent quarter.

Bases of ordnance and coal supply, equipment material and fittings, engineer's stores, provisions, clothing, and appliances of every sort that the varied emergencies of war may call for, should be located and determined upon, at points the most remote and best sheltered from possible torpedo attack. I take it for granted that England's latest torpedo craft, of great speed, have sufficient seaworthiness to enable them to reach our coast from Bermuda with comparative ease. If such be the fact, they would prove to be ugly vessels to deal with, in the event of war with England. Our supply vessels, even under strong convoy, would have to be careful in their movements, to avoid being torpedoed.

The development and speed and the destructive powers of the

torpedo-boat would seem to indicate a new departure, if not another revolution, in naval warfare, which will have to be vigorously met. The huge battleship or the heavy cruiser, attacked by torpedo craft of 30 knots speed, in groups of five or more, would be apt to suffer like an animal attacked by a swarm of bees, especially under misty conditions of weather or at night. How readily the most watchful vessels can be approached by the low swift torpedo vessel at night, or during the drowsy hours just before dawn, only those who have had such experience can tell. The approach of the *David* that torpedoed the *Ironsides* off Morris Island and sank the *Housatonic* outside the bar, was discovered in good season, but not in time to prevent her getting in her nasty work, although her speed could not have been more than five knots.

Problem: You are lying in Gardiner's Bay, or in this harbor of Newport. It is 3 o'clock in the morning, a light mist hangs over the waters, but the search lights you display indicate your position to an alert enemy. All of a sudden the officer of the deck and the lookouts descry a torpedo-boat of 30 knots approaching at full speed. The alarm is at once sounded, but the men of the watch, already at the guns, though ostensibly awake, are in that drowsy state that makes one rub the eyes before thought can be sufficiently awakened to do quick, clear-headed work. Meanwhile the torpedo-boat is upon you. You may get in one shot, but the next moment the torpedo has done its work! This picture is not overdrawn; with the exception of speed, it is sketched from personal experience. But if several torpedo-boats attack you simultaneously under like conditions, your destruction is certain.

On this head I was somewhat amused at the report that came from Charleston one day last winter, when the simulated blockade had been established there by Admiral Bunce. The report said that after several days of exhausting blockade labors the admiral had suspended operations to give his people a little rest.

As my friend Bunce and I had served together on such duty at the same place, in time of war, year in and year out, without any relaxation whatever, it occurred to me that he must have smiled in reminiscent thought when he dictated the order in question.

But to return to the consideration of the torpedo boat, wise

administration would point to the building of one hundred or more of such craft, staunch and swift, and of model and tonnage to make them reliably seaworthy under the general conditions of our Atlantic-coast weather. Unlike Mr. Jefferson's gunboats, such vessels under their chosen conditions, which their great speed would allow, would match an enemy of much greater bulk, and equal him in other directions. One or more cable-laying and cable-destroying vessels should also be provided, for, in the event of a war with England, one of the most important things to do would be the destruction of the cable system that connects Bermuda and Jamaica with Downing Street. A British officer has said that "Bermuda holds a pistol at the head of New York and Boston." It behooves us then to be ready at the first stroke of war with England, to prevent the too ready use of that ready weapon.

The New York Herald does not take such view of submarine cables in any respect. It thinks the United States would do a sensible thing "if it took the initiative in proposing a congress for the consideration of the question looking to putting submarine cables under the protection of international law." The United States has done some foolish things. Admiral Porter used to say, indeed, that the Almighty took special care of drunken sailors and the United States of America; but if we consent to submarine cable immunity—an immunity that may at any time in war work towards our disaster, especially in a war with England, whose forts, dockyards, and arsenals, from Halifax all along our Atlantic and Gulf coasts, to the dominating naval stronghold at Esquimaux on Vancouver island, at the entrance of the straits of San Juan de Fuca in the Pacific, constitute an ever-present menace to us—our foolishness will have reached its apex!

Yet can it have reached the apex when we consider that under the stress of our present relations with Spain, Japan, and England, Congress has adjourned, knowing that its enacted law as regards the price of armor, urgently needed for the battleships under construction, cannot be accepted by the firms engaged in such fabrication, except at a loss? What man, in truth, of ordinary intelligence, divorced from partisan considerations, can contemplate with simple candor and clear-eyed examination the present condition of our international relations, without coming

to the conclusion that war's stern encounter may be thrust upon us by one or more of the three powers named, within the next twelve months. Nor need it be said that the recent discoveries of gold in the Klondyke region of Alaska have not lessened the strain of our relations with England, as regards Canadian affairs.

In rebellion days, the major part of the telegraph lines being held by the insurgents, communication with the Department by our fleets was mainly maintained by water. In the event of war with a maritime enemy, our natural and ever-ready means of communication would be by land, provided the land and sea forces were able to keep open and protect such points of access; wherefore dispatch vessels for long-distance sea communication would not be imperative, as was the case during those memorable years of our civil war.

I do not know what provision this college has for the study of questions of strategic importance relating to harbors and anchorages and their relations toward operations in war, defensive and offensive, but certain it is, no officer can know the conditions of intelligent decision and successful movement from charts and books alone. Topographic features of coasts and harbors are as necessary to know as the hydrographic conditions of their waters, and it seems to me that for the best study of naval operations, a ship should be placed at the use of the president of this institution, to enable him to give the students, through practical examination, a thorough knowledge of the various points adapted for both defense and offense that an enemy would be likely to assail. A War College should have the means of forecasting war purposes and to formulate measures to meet and defeat such purposes of an enemy.

Where to draw the line between naval administration for war and for peace is a question, but it may be safely affirmed that such administration in war is the more concise, sensible, and effective; for, once the dogs of war are loosed, much discretion and independence of action must be conferred upon officers afloat in face of the enemy, or things will go awry and invite defeat. In the heat of war's fierce glow, red tape blanches white, then withers to ashes of disuse.

This recalls the story of the frigate *Columbia* at the Norfolk yard, away back in the forties. The ship had arrived from a foreign station to go out of commission. As she was hauling in to

her designated berth, the first lieutenant of the yard and the first lieutenant of the ship were at odds as to the manner of doing it. Said he of the yard, "Commodore Sloat wishes you to haul in on your stern line, sir"; but, broke in the "first luff" of the ship, "Commodore Blank wants a pull of the bow line, sir!" And so, until the ship got alongside the sea wall, the bandying went back and forth, much to the delight of the chuckling midshipmen, radiant over the fact that there were folks who dared "talk back" to the dogmatic, assertive "first luff" of those salty days.

One of the gravest problems confronting us to-day is the problem of manning our fleet in the event of war. We know that our deep-water merchant marine is gone, and under conditions that seem to make its rehabilitation almost beyond hope. We will be obliged, therefore, to turn to our coasting, river and lake craft for men to man our battleships and cruisers. Any plan or scheme to raise a force for service afloat, outside and beyond the control of the Navy in its character and scope, as one of the great arms of the national defense, under the direction of one head, will be, in my judgment, a grave mistake. At the outbreak of the rebellion, several bodies were raised for semi-naval operations. It soon became apparent, however, that such organizations should be merged in the Navy, if effective work was to be expected from the excellent personnel composing them.

In these days we know that bodies of naval militia have been organized by several of the seaboard and lakeboard States. Such movement has the active coöperation of the Navy Department, acting under the authority of Congress, and we may not doubt that in the event of war such organizations will do excellent service; but I submit the opinion that for harmonious and effective working, they should come into the Navy in the same manner as did the officers and men of our merchant marine in 1861. Wise administration would seem to dictate such policy, especially in the light of former experience.

During the war of 1812, the militia of some of the New England States refused to go outside of their respective state lines. It is to be hoped that like action will not be the outcome of the present movement to a quasi-naval reserve. Let us suppose that, in the pinch of war, an admiral's chief-of-staff were to say to the commanding officer of a Massachusetts force of naval militia, "The Admiral wishes you to proceed, sir, to Portsmouth,

N. H., and there await further orders," and were to receive this reply from the officer addressed, "But, sir, the Governor of Massachusetts wishes us to remain here!" It would be rather an awkward situation; but, unless my historic reading is at fault, something akin to such response and situation happened in one or more of the New England States in the war of 1812.

We already have two great organizations for national defense—the Army and the Navy. The two arms, in the nature of things, never worked so harmoniously together as to suggest still another, to add to clashing and complication.

An old petty officer of the service, in his occasional visits to me, speaks of the Massachusetts naval militia as "the swallow-tailed sailors from the Back Bay"; but that organization is made up of splendid material, and like the Eton boys at Waterloo, or our own lads who ran away from school and joined the ranks at Gettysburg, those web-footed militia will fight if but given the opportunity; but to get most efficiency—the best results in war time—their fighting efforts should be held under naval direction, utterly independent of State authority. At present the naval militia of Massachusetts is under the supervision of a soldier, the adjutant-general of the State. I cannot imagine anything more absurd. Wise administration in war will eliminate such an anomaly.

In January, 1896, Captain Eardley Wilmot, R. N., published a most original and interesting brochure under the heading of "The Next Naval War," illustrative of England's real unpreparedness for war, and the defects of the dual war office and admiralty control in the matter of coast defense. Let me quote a passage from it:

It may be imagined what excitement prevailed throughout the country when it was known that war was actually declared. It was simply chaos. Has it not been stated of Moltke that on a similar occasion he was found reading a novel, and surprise being expressed at his being so engaged, he said: "The great work of preparation now ceases; we have to see the results of our labors." There was no such spirit at Pall Mall or at Whitehall. Many things that had been suggested as necessary, but put off, had to be taken up. One department besieged another with inquiries, demands, and requisitions. In addition, telegrams from the coast came pouring in. The military, having been intrusted with the safety of the harbors, had provided an elaborate system of defense by submarine mines, which necessitated the greatest precaution in going in or out. It had been wittily remarked there would be more risk in

time of war to our vessels entering their own harbors than approaching those of the enemy. This was now realized, for on an intimation from the War Office that the ports were to be placed in a state of defense, mines were laid in all the channels, and a dockyard tug coming into Portsmouth harbor, from a short cruise to warn friendly vessels of the condition of affairs, had first been diverted from her course by the persistent glare of a search light, and then ran against a loaded mine, which resulted in her being blown up, with all hands. This led to an angry discussion between the admiral and general. The latter said that, being responsible for the safety of the port, he must exercise his own discretion as to when and where mines were placed. Vessels should wait outside until they could be conducted in by a corps of pilots he was organizing. It was suggested that such delay might be of value to an enterprising enemy, and the admiral stated with emphasis that the dispatch of reinforcements to the fleet with promptitude depended upon his having full control of the immediate waters of the ports.

There was no alternative but to refer the matter to headquarters, and the attempt was made to define the responsibility of such service. This, on going into the matter thoroughly, was found to be hopeless. The First Lord plainly declared that unless the admiral was supported he must ask to be relieved of his office, and the Prime Minister seeing the urgency of the case, directed that the supreme control should be vested in the naval authority. This was nowhere received with greater satisfaction than at the ports, for in the meantime the generals in command had arrived at a sense of the anomalous position in which they had been placed. Soldiers had been allotted to complete the manning of the ports, but they had not the slightest idea of what constituted friends or foes. They could with difficulty be restrained from firing at everything that approached.

At the request of the officers in command, a naval party was sent to each port, who could pronounce upon the character of every craft that came near. It was found that forts, lights, and submarine mines could be worked efficiently as a single organization, but under dual control it must result in chaos and probably disaster. Barely two years before, the French Minister of War had pointed out in the chamber, and every other nation had adopted the policy we now found essential. But such a change can not be perfected in a few hours, and the enemy was not blind to the experience of the past, which has always found us unready in the early stages of a conflict. He knew that give us time and all these defects would disappear. Everything depended upon striking immediate blows. These were about to fall.

How graphically this description of lack of system, divided control, and perennial unreadiness depicts our own conditions and methods, as well as our ever woful lack of preparation to meet the ruthless demands of sudden hostilities! How admirably the gifted writer dissects and limns the follies and disastrous

plights of dual control of harbor waters in time of war, a control which with us would be the more difficult and complicated because of the closer touch of army men with the political forces of the country than navy men have, and the precedence given to that arm of the national defense; although in 1836, General Cass, as Secretary of War, said, in his annual report to the President, "That for defense of the coast, the chief reliance should be on the Navy; and that the system of 1816—that of the Board of Engineers—comprises works which are unnecessarily large for the purposes which they have to fulfill," to which opinion, the President, General Jackson, than whom this country has produced no abler soldier, gave his emphatic approval. But admitting as inevitable dual action and control of the Army and Navy, in harbor and coast-line defense in war time, under our conception of prerogative and systems of administration—civil, naval, and military—the advent of the naval militia as a third body of defense, under State control, would make "confusion worse confounded." I repeat, then, the opinion, that upon the outbreak of war, the officers and enlisted men of the naval militia should be temporarily absorbed by the Navy and made a part of the national force, as in rebellion days. Furthermore, I venture to say that sudden war would make the demand for men to man all our ships so urgent as to require the instant absorption of not only the naval militia into the regular service, but all the young men trained to seamanship on board the several State training-ships, and our yachting craft as well as our lake-board vessels. The stress of war cannot await the delays of theory; action pronounced, instant, and energetic can alone meet the emergencies of hostilities and the urgencies of administration incident thereto.

Fleet holiday showing as to efficiency for cruising and war is not to be relied upon, as I have said before. Let me further quote from Captain Eardley Wilmot's able paper on this head:

The French had sent an ultimatum to England, which made the instant mobilization of England's fleet necessary. Seeing [says the gallant writer] what had been accomplished every summer for some years past, in mobilizing a large fleet for the annual manœuvres, and observing that with few exceptions and breakdowns we were able practically to double our squadron in home waters within forty-eight hours, it was hoped on this occasion there would be no difficulty in producing a like result. But it was soon seen that this was no criterion of our preparedness, *for on those occasions, with the date well known, this evolution had been*

*the special care of the dockyards for months previously. The manœuvres over, vessels that had participated in them were put aside, reports of officers in command as to urgent requirements were unheard, while all the energies were directed in pushing on new constructions, so as to show how rapidly a modern battleship could be produced.**

Though by dint of considerable pressure on the War Office, the ammunition for all vessels in the reserve had been provided, it was not kept in a convenient locality and had to be transported in lighters. A sufficient number of these, with due warning, could be hired, and it had been a novel sight in previous years to see a dozen ships simultaneously taking in this powder alongside the dockyard. But to send such an order without notice and at another time of the year was to find those responsible for this important part of naval equipment quite unprepared. Indeed, when the port admirals, on receipt of the order to mobilize, sent urgent demands for powder and projectiles, the ordnance store officers declared themselves unable to move until proper requisitions from headquarters had been received and arrangements could be made for transport. Then the anomalous condition, which places the most important and essential portion of a ship's fighting capacity under military control, was apparent. True, both services use powder and in theory a common store is economical, but why should not the navy supply boats, on the same reasoning, to soldiers and sailors? Anyhow, here was the first cause of delay, and the red-tape barrier was only overcome by the energetic action of our admiral, who at once sent an officer of his staff to assume command of the depot, while another was dispatched to hire all the lighters in the port. He remembered the procedure of Sir Edmund Lyons, when he had to make arrangements for landing in the Crimea, and the shock caused in the official mind by his prompt dealings at Constantinople with owners of necessary stores. But a little irregularity on these occasions wonderfully facilitates the movement of an army or fleet. It was found so now, for in a few hours twenty lighters had been found, loaded, and dispatched to the vessels fitting out.

Then a new difficulty arose. Orders had been received to fill up the crews of the coast-guard ships and commission every vessel in the reserve. There was now found a considerable dearth of men. The coast guard, a most efficient force, of about four thousand men, could only be drawn upon to a small extent, because to them was intrusted the important duty of working the signal stations which we had established all around the coast of the United Kingdom. This was an invaluable piece of organization, because it enabled the appearance of any vessel to be flashed to all parts. The efficiency of it, however, depended upon the men at those places being able not only to distinguish between a merchant ship and a man-of-war, and to detect the latter if disguised, but to know by appearance the nationality of an approaching cruiser. The experience of the coast-guard men made them adepts at recognizing their own vessels, and being furnished with photographs of foreign war vessels they could identify any hostile cruiser. Clearly their places could not be taken by

* Italics are mine.

landsmen, as had been proposed, or even seafaring people without experience. Hence the coast guard could not be sent afloat in any numbers.

The naval reserve was called out, but no one knew where the men were coming from, or in what numbers. As they mostly belonged to the principal steamers, the owners regarded with dismay their vessels depleted of men. The slow steamers and sailing ships, which were likely to lay up in war, carried few, if any, reserve men. It was seen that we had been trusting to a broken reed in our system for manning a large fleet at prompt notice. A week had elapsed before even five thousand of these men had reached the ports, and few having served in a man-of-war, they had not only to be instructed in the most elementary routine duties, but it was a week before they could find their way about the ships to which they were sent.

These pictures of maladministration, so ably drawn by our distinguished kinsman of the sea, are in no whit overdone. In the blunderings he depicts, with so searching an eye, so fearless a pen, we feel that more than ever we are "chips of the old block." It is, we may not doubt, a peculiarity of the Anglo-Saxon race, that up to a certain point of preparation for war he is unequaled. In marine affairs, affairs that concern him most of all, he recognizes the necessity of having ships and guns—powder and projectiles of latest type—power and efficiency for both defensive and offensive purposes, but when it comes to the most vital part of the whole organization as to personnel, which will provide equally in war or peace crews for the otherwise ready ships and fleets, he is sadly at fault.

The drawbacks of the British system, so plainly disclosed, we cannot think are overdrawn; the remedy for the shortcomings outlined is difficult to apply, owing to the temperament of the British race and its abhorrence of coercion in any form. The days of the pressgang with its brutal methods are no more. The men of the British merchant marine—of whom to-day not less than thirty per cent are foreigners—will not enter the Royal Navy. The memories of the old-time discipline of that service, rigid and unrelenting, oftentimes unfeeling in its incidents and cruel in its punishments—linger in the British mind and deter men from entering that arm of the Queen's service. The marine conscription that the continental powers enforce with such vigor no British ministry would venture to try in the British Isles. Yet there has been a wonderful amelioration in the condition and treatment of the British man-of-war's man during the past

forty years. Privileges that in Nelson's time would have been looked upon as preposterous and dangerous to authority are now freely granted. The question of manning her fleet has ever been the more serious to England, because of the vital necessity of the readiness and efficiency of that fleet to her very existence as a power. Wherefore, in these later years of naval demand the British Admiralty has adopted the plan of long enlistments, an extended and effective system of training ships and schools for boys, a carefully-devised scheme of pensions for long-service men, and a well-considered grant of privileges to their seamen, astonishingly democratic in character. The British man-of-war's man feels to-day that he is the most important factor in the Empire, and what he once ventured to ask for with fear and trembling, he now boldly demands.

In the wise spirit of conciliation and justice with which he has been met, he is made to feel that his interests lie in the service, that he is a man to be considered, and he concludes to remain in a service that accords so much to him, as an indispensable factor of the national life.

Have our seamen met with such judicious treatment? Let us give a case in point. In the height of our civil war the time-honored grog ration was suddenly abolished in our Navy. Not a single seaman was consulted as to his wishes in the matter nor as to its expediency. Old salts who had served in the war of 1812 and the Mexican war were abruptly told one day that there was no more grog for them, and it hit them hard; so hard, indeed, that many of them left the service for good after the war. The British Parliament would never have ventured upon such an invasion of centuries-old sea ration and custom, without taking the sense of those most closely affected.

But despite England's administrative efforts toward the maintenance of an efficient and unfailing personnel for her navy, it is undoubtedly a work of great difficulty, for disablement, desertion, and death, and the requirements of foreign stations strain her seafaring resources continually and to the utmost. And when it is claimed that the ships comprising the recent jubilee display at Spithead were in all respects ready for war service, I repeat that we may well doubt it. Probably not half the vessels of that holiday occasion were really ready for battle or cruising purposes. The conditions of the mythic fleet so vividly

portrayed by Captain Wilmot would doubtless have found some counterpart at that great marshaling of England's fleet—echoes of whose real unpreparedness will doubtless from time to time break upon the world's ear, as the memory of that spectacular demonstration fades into the past.

A word more and I have done with Captain Wilmot's remarkable paper, although its entire presentation of the situations and happenings it deals with in imagined naval chronicles ought to be carefully read and heedingly considered. That word is to suggest the fact that whatever have been the shortcomings of our own naval administration, whether in peace or war, we have not been at all dependent upon the army establishment for our ordnance or any detail of supply or equipment pertaining to it, since the war of 1812 and perhaps prior to that period. Our advantage over the British Navy in that respect is marked and distinctive. No Woolwich gun factory or arsenal under army control has stood in our way or balked naval endeavor. Our naval ordnance was superior to that of the British naval service in 1812 and has continued so ever since—barring the interregnum after the civil war when we rested on our oars and looked on while other nations did the experimenting, until the problem of safe and effective rifled cannon of high power had been satisfactorily solved. Then we know that our Bureau of Ordnance, which had kept itself thoroughly informed on every incident of progress and factor of success abroad, set about in earnest under the able lead of Captain (now Rear-Admiral) Sicard—the chief of bureau—and his assistants to build guns for our Navy. This was the more readily accomplished because of the progressiveness and thorough business methods of Secretary Whitney, in his brilliant administration of the Navy Department during Mr. Cleveland's first term. The naval gun factory established at the Washington yard stands as a lasting monument to his enlightened grasp of naval needs and of his administrative genius on new lines of effort.

The guns built at that establishment, whether of small or large caliber, have not been surpassed in strength or safety, power, and endurance, so far as I have been able to learn, by any guns made by the most celebrated gun makers of Europe. In truth, if my memory serves me correctly, guns have burst in use on various occasions on board the ships of England,

France, Germany, and Russia, but no accident of such gravity has yet happened to our ordnance, planned in every detail by our officers and built under their direction.

In the early forties the frigate *Cumberland* bore the broad pennant of Commodore Joseph Smith as commander-in-chief of the Mediterranean. Captain Samuel L. Breese was her commanding officer, and Lieutenants Andrew H. Foote and John A. Dahlgren were first lieutenant and flag lieutenant, respectively. They were all regarded as officers of great merit—a reputation more than confirmed by their subsequent services, both in peace and war. They were also warm personal friends and ever hung together. It was during that cruise in the *Cumberland* that Dahlgren told Foote he had become so much interested in ordnance that he was going to make it his service specialty. The result was, as you all know—after much obstruction on the part of his seniors, but persistent effort and stout battling on his own part—the Dahlgren system of ordnance, which, up to the advent of the safe high-powered rifled gun—which took many years and enormous expenditure of money to accomplish—was undoubtedly the best gun in the world, especially for naval purposes.

The last time I saw the admiral was in March, 1865, when, Charleston having fallen, I was detached from his command and ordered to join Admiral Godon's special squadron to Havana, in quest of the rebel ironclad *Stonewall*. When I called to bid him good-bye, he seemed to be much disturbed at a letter he had received from the Bureau of Ordnance, asking his consent to have his 9-inch and 11-inch guns cast in future on the Rodman principle. He talked more than an hour in the most fascinating way upon the subject of naval ordnance. Among other things, he said, "Several thousand of my guns have been in constant use during the war, and not one of them has burst or shown the least sign of weakness. Nor have I ever received a cent of royalty from the Government." "Now," he bitterly continued, "they want to change the character of their construction, but they shall not do it with my consent." He was certainly justified in his anger.

He was unquestionably the ablest and most accomplished officer in ordnance of his time, whether in our own service or in any other. To his genius and labors, let me repeat, the country was indebted for the best and most effective smooth-bore

guns the world ever saw. The perfected rifled gun of this day has alone rendered them obsolete. It is said that his last days, like those of Dupont, were embittered by belittling procedures at Washington, which left their sting of injustice and brand of discourtesy to rankle in his breast and hasten his end.

Some time after Admiral Dahlgren's death, his widow asked Congress to vote her a sum of money, as a recompense for her deceased husband's eminent work in ordnance, especially for the heavy guns he had devised. While the bill was under discussion in the Senate, General Logan, who, with his army experience, ought to have known better, arose in his place and said, "There must be some mistake in this matter, for navy men do not know how to make guns. Our heavy guns are all made by army men, on the Rodman plan." This dictum is mentioned to illustrate general ignorance as to what the Navy does and has done. The only Rodman guns ever used in the Navy were the 15-inch guns of the monitors. Dahlgren opposed their being cast on the Rodman plan, but was overruled by Secretary Welles and the Bureau. Inasmuch as no gun cast on the Dahlgren system ever burst in action, while one of the 15-inch guns of the Mahopac blew off its muzzle after a few rounds at Fort Fisher, and several of them cracked inside at the bottom of the bore, in the region of the vent, Rodman and his friends are quite welcome to the glories of the 15-inch gun cast on the General's process.

In a little service talk I had with General Abbot of the Ordnance Corps—now retired—at Atlanta some two years ago, he was loth to acknowledge that the Navy was the first to make the built-up rifled guns in this country. I insisted that the Navy not only established the first plant for the building of such ordnance, but had turned out several guns before the Army moved in the matter at all. If my statement was too positive, I will be glad to be corrected.

It was perhaps a happy circumstance that our captains during the civil war were unhampered by constant touch with Washington, otherwise the victories won at Hatteras Inlet, Hilton Head, Forts Jackson and St. Philip, and Mobile Bay, might have known no place in our annals. But let us give due acclaim to our naval administration in war which gave so much discretion to our flag officers, allowed them to promote volunteer officers for gallant services on the spot, supplied them most lav-

ishly with means for effective work against the enemy, and kept the service a regular organization from first to last. With us of the Navy there were no State organizations. There was no Fifth New Hampshire, Sixth Massachusetts, Tenth New York Regiment and the like to deal with, as was the case with the Army, as to its domination, but it was ever, as before and always, the Navy of the United States.

When officers were appointed from the merchant marine, they were received with honor and given due position, but never highest commands. Moreover, when it was suggested in some quarters that Assistant Secretary Fox, Captain R. B. Forbes, of Boston, and one or two other distinguished men of sea training should be made rear-admirals, the old-time battle-seasoned officers of the service had the courage and influence to stop it.

In conclusion, I pray you study the naval history of your own country, its naval administration, and the lustrous achievements of your brothers-in-arms who have gone before; achievements, not so varied in character, nor so extended in scope, indeed, as the stirring deeds of the great British seamen which Mahan has so vividly portrayed, but every whit as brilliant in conception, daring in execution, and momentous in results.

The English have been wont to say that Napoleon never encountered a first-rate general until he met Wellington, but in all his fighting Lord Nelson never had to contend with a first-rate man of the sea. His victories were all won over second-rate, half-hearted captains, as at the Nile and Trafalgar, or men taken by surprise, as at Copenhagen—that most notable naval instance of national assassination of modern times.

What a difference he would have found, we may think, in battle tests with a Farragut or Porter, a Foote or a Rowan! Had it been his fortune, in truth to meet in battle seamen of such intrepid sort and unfailing resource, I venture to say that his epitaph would have been differently worded!

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

INTERNATIONAL LAW. NAVAL CAPTURES.*

By GENERAL FRANCIS J. LIPPITT.

Mr. President and Gentlemen:

My lecture is nothing but a long series of propositions of dry law, and, of course, must be more or less tiresome to any other audience than one of professional lawyers. I am therefore somewhat reluctant to read it to you, but I shall venture to do so, hoping that your interest in the subject is such that you will not find it to be *too much* of a bore after all.

As a full discussion of the subject of naval captures would be impossible in a single lecture, I shall limit myself to stating the principles governing in such cases as most often occur.

In time of peace no capture can be lawfully made except in the case of piracy. But where a vessel, whether a domestic or a foreign one, has been violating the laws of a country, the nation's cruisers may lawfully pursue, stop, and bring her in. In the case of a foreign vessel, the chase, it is said, should have commenced within the three-mile limit, or else the vessel must have just escaped from it, as in the case of the Chilian ship *Itata*, supposed to have been violating our neutrality laws. But in this instance the seizure is made, not *jure belli*, but in the cruiser's performance of national police duty, and is not a capture in the proper sense of the word.

In the case of piracy—now extremely rare, except in certain Asiatic waters—the captured vessel must be brought in for adjudication by an admiralty court, and her condemnation entitles the captors to prize money.

* Lecture delivered at the U. S. Naval War College, July 23, 1897.

In respect to these two cases of seizure, the right of visit and search would be necessarily implied. The exercise of this right requires the utmost caution; since, if a mistake has been made, the commander would be legally liable in damages. But if the visit and detention was fully justified by the circumstances, it would not constitute a serious cause of complaint against the cruiser's nation; and though the commander might be mulcted in damages, he could justly claim to be indemnified by his government.

As to piracy: it is important to bear in mind what piracy really is under international law, which characterizes pirates as *hostes humani generis*, enemies of mankind, robbers on the high seas. And the question always is whether the intention of the supposed pirates is to capture and destroy *jure belli*—by right of war—the property of a particular nation or government with which they are fighting, or, on the other hand, to depredate criminally on the ships of all nations for private gain—*animo lucrandi*—which alone is piracy under international law.

Piracy, made so by a nation's municipal law, is a totally different thing, as for instance, our act of 1790, declaring robbery on the high seas of an American vessel by our own citizens to be piracy, and making it punishable as such. So, while the slave trade lasted, by treaties between certain nations it was characterized as piracy, and their respective war ships were empowered to visit, search, and capture each other's private vessels that were engaged in it. That trade being now abolished, those treaties have become obsolete.

It follows that, although insurgents may be treated by their own government as rebels and pirates, they are by no means pirates under international law. Apart from the enforcement of a nation's neutrality laws, it has no right to assist in the suppression of an insurrection which concerns only the insurgents' own government. In fact, the motives of insurgents are often patriotic, and other nations have no right to judge whether an insurrection is justifiable or not. And so long as the insurgents' government insists that no war exists, it has not the belligerent right of capturing them on the high seas.

In 1873 the British ship *Deerhound* was captured by a Spanish cruiser on the high seas, with arms and munitions of war for the insurgents under Don Carlos. Great Britain claimed that as

there was no war declared, there existed no belligerent rights; and Spain had to restore the ship and release the passengers, including Don Carlos himself.

In the same year the steamer *Virginius*, carrying the American flag, was captured by a Spanish cruiser on the high seas—no war admitted by Spain to be existing—and carried into Santiago de Cuba, where the captain and fifty-two of the passengers were summarily tried and shot. The United States demanded of Spain: (1) Restitution of the ship; (2) release of the survivors; (3) signal punishment of the officials; (4) ample indemnity for the families of the American citizens executed; (5) a salute to the United States flag. All these terms were submitted to, but on its being ascertained that the United States flag had been fraudulently used, the salute to the flag was waived.

It is plain that a denial by the insurgents' government of the existence of war, while it is actually being carried on by organized forces in the field, cannot be allowed to prejudice the rights of other nations or of their citizens. Consequently, foreigners captured fighting in the ranks of the insurgents cannot be treated under international law otherwise than as prisoners of war, and their trial and execution by court-martial as rebels would be a lawful cause of war to their own nation. "Oh, but filibusters! filibusters!" some may exclaim: "They surely have no rights that a law-abiding people are bound to respect!"

This reminds me of the good old Quaker who, being one day very angry with his dog, said to him, "Friend, I will not hurt thee, but I can give thee a bad name!" With that he opened his front door and pushed the dog out, shouting "Mad dog!"

It is often asked, "What's in a name?" But sometimes there is very much in a name.

I would remark here, before passing to our main subject, that in no case whatever in time of peace can a war ship of one nation be subjected to the jurisdiction of any foreign one, and an attempt to do this would be a violation of her nation's sovereignty.

In 1879 the United States ship *Constitution* went aground on the coast of England. Assistance was rendered by a tug. A dispute arose as to the amount of salvage to be paid, and a warrant was applied for for the frigate's arrest; but it was refused by the government on the ground that, being a foreign war vessel,

she could not be made amenable to the jurisdiction of the country.

We now come to our main topic, Naval Captures in War.

War is always a terrible evil. Nevertheless it is sometimes unavoidable, as when there is no other means possible of vindicating the rights of the nation or of its citizens. Obviously the interests of both belligerents as well as humanity require that it should terminate as soon as possible. Thus each belligerent is justified in using the most efficacious means of inducing his adversary to make peace, and this is by inflicting on him as much loss as possible. In a maritime war this means the capture of his war ships and the property of his citizens floating on the seas, thereby ruining his commerce. Though, in a maritime war, the practice of nations does not sanction the capture of property on land, it allows the capture of all his property, public or private, afloat on the high seas or in his own waters. It moreover recognizes the right to blockade his ports and to levy a contribution on them, on pain of bombardment should it be refused.

Naturally the first question is, In what cases is capture of property lawful under international law?

For the sake of clearness, I shall consider: (1) Where a capture may be lawfully made, (2) the case of property belonging to the enemy, (3) the case of property belonging to the belligerent's own citizens, (4) the case of property belonging to a neutral.

1. A belligerent cannot lawfully act hostilely except on his own territory, on his own ships, or on the enemy's ships or soil. A capture, therefore, in the waters of a neutral is unlawful, being a violation of the nation's sovereignty. Nevertheless in a prize court such a capture, as between the two parties, is deemed valid. The nation aggrieved, however, has a clear right to demand indemnity of the neutral government, whose duty it was to keep the peace in its own waters.

In 1814, during our war with England, the American ship General Armstrong was attacked and destroyed, after a heroic resistance, by British war ships at Fayal in the Azores. Our Government demanded indemnity of Portugal. After many years it was agreed to submit the question to the French president as referee. In 1851, the referee decided that there can be no claim where the ship resisted, instead of demanding protection from the authorities. But must the ship wait till this formality is complied

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with, due deliberation had on the demand, and the demand either acceded to or refused, before firing a shot in self-defense?

2. Next, as to the case of property belonging to the enemy.

Enemy's property has always been liable to capture, even on a neutral ship; though, in that case, the master was usually entitled to his freight, it being a lien on the cargo. But this right was in some instances expressly waived by treaties between certain nations. Finally, by the Declaration of Paris of 1856, to which all nations were parties, except the United States, Spain, and Mexico, enemy's goods on board a neutral vessel are no longer liable to capture. The rule is briefly expressed by the term *Free Ships, Free Goods*. Of course this exemption would not hold where a fraudulent use is made of a neutral flag.

To this declaration the United States declined to be a party, unless *all* private property on the seas should be exempt from capture, whether belonging to the enemy or to a neutral. The ground of our objection was that in war it is necessary to destroy, as far as possible, the enemy's commerce, this being the most effectual means of inducing him to make peace; that the United States, having a small navy, which could not cope with that of a great naval power, could not afford to relinquish, even in part, her power of destroying the enemy's commerce, unless her own commerce should be protected by exempting *all* private property from capture.

But consider. Were all private property afloat exempt from capture, a naval war would consist only of combats between battleships, and the nation having the most formidable navy would be sure to win in the end; just as in military operations on shore, victory perches on the banners of him who has the heaviest battalions. The result would be that a weak naval power, in a contest with a powerful one, had better make peace as soon as possible.

Another rule established by the Declaration of Paris is the abolition of privateering.

To this article also the United States objected, on the ground that war is simply a trial to ascertain which nation can do the other the most harm, not from any vindictive motive—God forbid!—but as the only means of inducing the enemy to make peace. The importance of privateers in this respect is illustrated by an article in the *Edinburgh Review* in 1814, showing that in two

years the United States had captured, chiefly by privateers, over seventeen hundred British vessels with their cargoes. How much this fact may have contributed to the making of the treaty of peace in December of the same year we shall probably never know. Now, unless *all* private property should be exempt from capture, in a war with a great naval power, one-half of whose navy might suffice in a great measure to compel our own small navy to confine itself to defending our own coasts, the other half might be sweeping our commerce from the seas. Thus no other course would be left us but to employ the thousands of our merchant vessels and the thousands of our sailors thrown out of employment by the war, as privateers to be sent against the enemy's commerce. Abuses, no doubt, often occur in privateering, but they occur also in all volunteer armies, especially before, after much campaigning, they have become thoroughly disciplined.

What would be the result, in case of a war, of our refusal to become a party to the Declaration of Paris, it is not easy to predict.

In order to prevent any evasion of the belligerent's right to capture enemy's property, no change in the ownership of a vessel or of its cargo made *in transitu*, during her voyage, is recognized as valid, and the question always is, in whom was the property vested at the commencement of the voyage? If the cargo was shipped deliverable to a consignee in the enemy's country, the consignee is deemed to be the owner, and a delivery to the master is deemed a delivery to him; and it would consequently be held capturable. And so, under British decisions, as to goods shipped to a consignee, even in contemplation of war. But whoever was the owner at the beginning of the voyage, it is sufficient if the property belonged to the enemy when captured.

It has, however, been held that a transfer *in transitu* would be treated as lawful when conclusively shown to have been made in good faith.

3. Let us now consider the case of property belonging to the belligerent's own citizens.

Such a thing as a partial war is unknown to international law, which deems all the citizens or subjects of the respective belligerents, as well as their nations, as enemies to each other, and forbids not only all trading, but also all intercourse between them.

Since, the moment war has commenced, all trading or inter-

course with the enemy becomes unlawful, the offender's property would be capturable by cruisers of his own nation. A British subject's vessel, after war had commenced, was proceeding to the enemy's country merely to bring home his property there situated. She was captured by a British cruiser and confiscated by the British prize court, though no trading had been intended, the court holding that mere intercourse with the enemy is unlawful.

On this ground, were we a belligerent, one of our own vessels caught sailing under the enemy's convoy would be liable to capture by our own cruisers, and to confiscation of both ship and cargo.

Sometimes it is for the interest of a belligerent government to grant a license to its citizens to trade with the enemy. In such case the license covers only the articles specifically mentioned, and if it be abused, the licensed vessel is capturable by the belligerent's own cruisers. Moreover, the license does not protect from the consequences of a breach of blockade, or of carrying contraband of war, or against visit and search.

Again: All persons domiciled in our enemy's country, even our own citizens, must be treated as enemies, and their property is capturable as such. The status of belligerents as between themselves would admit of no other rule. Any other line of discrimination in the midst of hostile operations would be plainly impracticable. But should one of our own citizens domiciled in the enemy's country be a partner in a house at home, it would be only his share in the partnership property that would be confiscable. It follows, on the other hand, that the property of a subject or citizen of the enemy's country domiciled in ours is exempt from capture by our cruisers; but not so by the cruisers of his own nation.

4. We now come to the case of property belonging to neutrals.

There are three cases in which neutral property may be lawfully captured, which we will consider under their respective heads:

Contraband of war;

Breach of blockade;

Such a use and employment of the neutral's vessels as to aid the enemy in carrying on the war.

(a) And first, as to contraband of war. The right of a neutral to trade with any and all other nations, both in peace and in war, is unquestionable, but a belligerent has a right equally unquestionable to capture all neutral property destined for the enemy that would aid him in his hostile operations. Here, then, is a direct conflict between two equal rights. Obviously, one of these must give way to the other, but if the belligerent's right should yield to that of the neutral, the warlike supplies furnished by the neutral to the enemy would be ruinous to the success of the belligerent's hostile operations, enabling his enemy to prolong the war indefinitely. International law adjudges the belligerent's right to be the superior one. Now, this superior right can be enforced in no other way than by the capture and confiscation of the neutral's property whenever its nature and destination are such as to assist the enemy in carrying on the war.

The broadest definition of contraband of war that can be given is: All supplies that are peculiarly adapted under the circumstances to aid the enemy in his hostile operations, the term "supplies" being understood to cover also all military persons and dispatches. To enumerate the great variety of articles that have been held in certain circumstances to come under this head would consume too much of our time. I shall therefore confine myself to giving a few illustrations under the general principle; a full summary on the subject will be found in Snow's *International Law*, as edited by Commander Stockton, U. S. N., in section 61.

Always capturable as contraband articles are all such as would be of *direct* use in naval or military operations, as arms, munitions of war, and naval and military supplies of all kinds. As to articles of ordinary consumption in time of peace, such as food supplies, ordinary clothing, ship canvas and cordage, coal: under certain circumstances these might be as important to the enemy in carrying on the war as warlike munitions. Such articles, though innocent in themselves, would sometimes be held capturable as contraband, if destined to a port of naval or military equipment, but in other cases they would usually be held exempt from capture; and if appropriated nevertheless by the captors, they would be bound to allow a fair price to the neutral owner, and the freight already earned by the vessel. These articles, capable of use both in peace and in war, and such others as masts, ship timber, machinery, horses, money, are ordinarily innocent; and

so as to food supplies; but meat put up in cans, sea biscuit, and other provisions in a form especially adapted for naval or military use, would certainly be capturable if destined to a port of equipment, naval or military.

Manifestly, the law as to contraband must always remain in a fluctuating and unsettled condition. It is the interest of the neutral on the one hand to contract the list of the contraband, and of the belligerent on the other to extend it; and the decision as to contraband, or not contraband, belongs to the prize court having jurisdiction of the capture. When the articles in question are of the peculiar growth or manufacture of the neutral's own country, and carried in his own ships, more favor is shown to them in prize courts than in other cases; perhaps in view of the very just rule, that, so far as possible, the industries of a neutral nation should not be stopped by a war in which it has no concern.

In view of the uncertainty as to what might be adjudged contraband, maritime nations often stipulate by treaty what articles shall be deemed such in case of a future war between them.

In the capture of contraband, all other goods on board, though innocent, and even the ship itself, if belonging to the same owner, are confiscated. The ship also is confiscable when her owner knowingly allowed the carrying of the contraband, and the penalty attaches the moment the vessel has set sail on her voyage with the contraband on board. But she cannot be captured on her return voyage after successfully landing her contraband. She and the belligerent cruiser have been playing a game of skill, and the neutral vessel has won, and her subsequent capture would be an act of sheer vindictiveness, which international law does not sanction.

It is settled that the penalty for carrying dispatches to the enemy would not be applied to a mail steamer, which is under obligation to receive and deliver all mail matter delivered to it, with no opportunity to examine its contents. Whether this exemption would be recognized in a case where the owners of a mail steamer were actually aware of the contents of the dispatches, is a question that has not yet come up for adjudication.

In order to avoid capture, the neutral vessel carrying contraband is sometimes cleared for a neutral port; and, the better to deceive the belligerent as to her real destination, the cargo is sometimes landed there and afterwards reshipped. But if it ap-

pears that her ultimate destination was to an enemy's port, the voyage is deemed a continuous one, and confiscation follows of course. And so even when the cargo is not only landed but the duties are paid. Nothing short of the goods having been actually imported into the general stock of the country would prevent confiscation.

(b) We come now to the subject of blockade.

The object of a blockade is to prevent the introduction of any supplies to the enemy, and to suspend all trading or intercourse with the blockaded port. To accomplish this, all neutral vessels, whether entering or leaving the port, are capturable, with their cargoes. To constitute a valid blockade there are three requisites:

(1) It must be imposed by competent authority, either by the belligerent's government or by a naval commander possessing a general authority to that effect.

(2) It must exist in fact. No mere paper blockade is now recognized by international law.

(3) It must be so conducted as to make it dangerous for the neutral to enter or pass out, and a mere attempt to do so would authorize confiscation of both ship and cargo. Even hovering about, watching for a chance to enter or leave, is held to be equivalent to an actual breach of the blockade.

If the blockading ships are driven away by a superior force, the blockade is thereby ended; and if afterward it be recommenced the neutral must be notified *de novo*. But not so if driven off by mere stress of weather; in which case the neutral may lawfully avail himself of the opportunity for entrance or egress. And when a ship is compelled to enter by a distress that is palpable, immediate, and pressing, the penalty is not incurred.

Whenever there was knowledge of the blockade at the neutral's port, the mere sailing for the blockaded port makes the ship and cargo liable to capture at any time during the voyage; and ignorance of it is never presumed, though it may be established by evidence.

Formerly, when the neutral country was at a great distance from the scene of hostilities, as in the case of the United States and ports in Europe, prize courts usually presumed ignorance of the blockade for a certain period; but this presumption is now obsolete, since the institution of a blockade is now instantly known everywhere through the telegraph.

In justice to neutral ships lying in the port when the blockade commenced, a notice is given, usually of fifteen days, before their egress is prohibited. In such case, inasmuch as the belligerent's right did not vest until the blockade actually commenced, the ship may leave with all of the cargo taken on board before that time; but if any of the cargo was taken on board after the blockade commenced, she is liable to capture and confiscation.

After a breach the ship and her cargo remain capturable until the end of the voyage. The reason of this is plain. Her breach of blockade has forfeited ship and cargo and made herself liable to be pursued and captured. And if afterwards caught by the belligerent, whether at only 5 or 10 miles, or at 500 miles from the port—the voyage still continuing—it makes no difference in principle; but if the blockade has been raised in the meantime, she is no longer capturable.

As belligerents are bound to treat all neutrals alike, if one neutral vessel is allowed to enter, this nullifies the blockade as to all.

As to neutral mail steamers: They are allowed to enter if carrying no contraband, but they cannot engage in any trading in the port, and are bound to comply with all reasonable restrictions imposed by the belligerent during their stay there.

Under international law and usage there may be enforced a blockade in certain cases, even in time of peace, a breach of which by the neutral must be attended with the same penalties as in time of war. Obviously, a "pacific blockade" not binding on neutrals would be a mere farce—a nullity. But it has been held that in such a blockade the captured vessels should not be confiscated, but simply sequestered until the blockade should be terminated.

(c) We now come to cases where neutral vessels are liable to capture in consequence of certain relations with the enemy.

A neutral vessel, when used or employed in aid of the enemy's hostile operations, whether voluntarily or involuntarily—involuntarily, because otherwise the rule would be easily evaded—is liable to capture and condemnation. And so when sailing under the enemy's license, thus protecting from capture his own vessels, which would otherwise be employed in the enemy's trade.

It has long been the policy of maritime nations to exclude other nations in time of peace from their coasting and colonial trade, but in time of war a belligerent's vessels engaged in such

trade would be liable to capture by the other belligerent. It would be, therefore, of great advantage to him to permit this trading to be carried on by neutrals; but neutral vessels availing themselves of this privilege would obviously be rendering assistance to the belligerent nation, and therefore be liable to capture. The rule is that a neutral, in time of war, cannot lawfully carry on any trade with a belligerent not open to him in time of peace; but in more recent times the enforcement of this rule appears to be very much relaxed.

It would seem that, under general usage, a belligerent has no right to visit or capture a neutral vessel convoyed by a war ship of her own nation, but early in the present century a British prize court condemned a large fleet of Swedish merchant vessels, convoyed by a war ship of their own nation, Sweden being then a neutral and friendly power. The pretext was an alleged attempt to resist a visit and search of one of the vessels, but virtually, in my opinion, there was no actual resistance made, the convoying ship being obliged to submit to superior force.

It is now generally agreed that, whether resistance to visit and search by the convoying neutral ship would or would not justify capture and confiscation, the commander of the convoy should be required to give his personal assurance as to nationality and of their being no contraband on board, for the belligerent has a clear right to be satisfied on these points. Between certain nations there exists a positive agreement that the commander's declaration as to nationality and the non-existence of contraband on board shall be accepted. As for the United States, our regulations for the Navy of 1876 forbid the commander of a convoying ship to allow a vessel sailing under his convoy to be searched or detained, but require him to be satisfied as to its nationality and the non-existence of contraband going to an enemy's port.

This leads us to consider the subject of Visit and Search.

A belligerent has certainly a right to know whether a ship is enemy's property; or, if neutral, whether she is carrying contraband to the enemy, and to ascertain her real destination. This right can be enforced in no other way than by a visit and search. And this right is necessarily implied in the right to capture, for without it the right to capture would be obviously futile; and the exercise of it, if properly conducted—that is, if the boarding officer behave with proper courtesy, doing no injury, and with-

drawing immediately after the search—no neutral nation would deem it a serious cause for reclamation. Of course the right can be exercised only on the high seas, and never in the waters of a neutral state.

A resistance to search justifies capture and forfeits both ship and cargo, but not where the existence of war was unknown. In such case resistance would be justifiable, since the right of search does not exist in time of peace. A mere attempt at flight before possession is actually taken is no ground for condemnation.

The boarding officer should be accompanied by two or three men only, with a view to prevent any inclination to insulting or overbearing conduct. For any injury to the vessel or cargo, or for any oppressive conduct should the vessel be brought into a prize court, it would inflict compensation out of the fund in court, and no unnecessary detention would be lawful, and no act beyond the scope of the object in view is permissible; but the search may be thorough, including an examination of the ship's papers and log-book, of the cargo, the equipment, the crew, and the nationality of the passengers. Any of these particulars might throw light on the nationality and the destination of the vessel and as to the existence of contraband. Concealment or spoliation of material papers would be ground for condemnation, unless satisfactorily explained. The use of *false* papers, made to deceive, would always be ground for capture and confiscation.

A belligerent ship sometimes requires the vessel to send her papers on board the cruiser for examination; but this should not be. It is surely enough if the neutral vessel passively submits to be stopped and searched, without being forced to take any active part in her detention.

Under our regulations, the belligerent ship may use the enemy's flag; but before a gun is fired, either as a signal or in making a capture, it must be hauled down and the national flag displayed.

The flag is *prima facie* evidence of nationality; but in time of war a neutral vessel would not be condemned for carrying the enemy's flag as a prudential means of avoiding capture by him, nor for clearing for an enemy's port in order to escape molestation.

In 1861, during our war with the Confederate States, the British mail steamer *Trent*, commanded by a naval officer, was sailing

from Havana to an English port. At Havana came on board as passengers Messrs. Mason and Slidell on their way to England on a diplomatic mission from the Confederate government. The steamer was stopped by the United States steamer *San Jacinto*, Captain Wilkes, and the two men were taken from on board of her and carried to the United States as prisoners of war in spite of the indignant protest of the British commander.

There is no principle of international law by which the action of Captain Wilkes can be sustained. The men were not soldiers or military persons going to join the enemy, but mere diplomatic agents sent to a neutral country, and therefore not capturable as contraband of war. And as to their dispatches: as we have already seen, whatever their contents might be, no responsibility attaches in the case of a mail steamer, which is therefore exempt from capture on that particular ground. If exempt from capture, she is also exempt from visit and search, for the right of visit and search, being merely auxiliary to the right of capture, must fall with it. Again, there could be no presumption that the dispatches were of a hostile nature, since their object may have been to solicit peaceful mediation by the neutral government to which they were addressed.

It is true that a technical right to visit is supposed to exist in all cases, as a belligerent's discretion cannot be restricted by any fixed rule. But this right is subject to one limitation. It is based on the possibility that the vessel to be visited may be found to be liable to capture, either from her being enemy's property, or from her destination, coupled with the nature of her cargo. Had the *Trent* been sailing, really or apparently, for an enemy's port there would have existed a possibility that she might be found to be liable to capture. In that case, under the general rule, Captain Wilkes's technical right to visit her could not be disputed. The *Trent* was known to be neutral property, and sailing not for an enemy's port, but from one neutral port to another. As for Mason and Slidell, they were known not to be military persons, and therefore not contraband of war. Thus the possibility of her being found liable to capture—the sole ground of the right to visit—was flatly negatived by the known facts of the case. Even assuming that the *Trent* was technically liable to visit and search, simply taking persons from on board of her and then letting her go, without the judgment of a prize court, which

she was entitled to have, was a gross violation of her nation's sovereignty. England's claim of right to do this very thing was one of the chief causes of our war of 1812. Thus in demanding reparation for Captain Wilkes's action she placed herself on precisely the same ground on which we stood before our war with her; so that on our own principles we were bound to accede to her demand for reparation.

If Captain Wilkes had brought in the *Trent* for adjudication, he would have clothed his conduct with an appearance of legality. In that case our own prize court, there not being the least scintilla of probable cause, would have restored the ship and held him responsible in damages; and had we not promptly made the reparation required, Great Britain would have had against us a just cause of war.

This leads us to another important topic: The Duties and Responsibilities of Captors.

I will remark in passing that a neutral nation may forbid prizes to be brought into its ports except under stress of weather, to leave immediately afterward.

Captors are personally liable in a prize court for a capture without probable cause. In such case the ship and cargo would be restored, and the captors mulcted in costs and damages. And even in case of condemnation, compensation would be made for any loss arising from the captor's want of care. At his peril he must place an adequate force on the captured ship with a competent prizemaster, for whose conduct he is responsible. But there is no responsibility for loss by the perils of the sea.

He must bring or send in his prize for adjudication without delay, and commence proceedings at once by a libel in the prize court. Should there be unnecessary delay in bringing in or in commencing proceedings, demurrage is allowed to the claimant. The rule is inflexible in regard to privateers, but a war ship may sometimes not be able to comply with it, being under orders which may detain her. Not only must the prize be brought in without delay, but it must be to the most convenient home port, otherwise the claimant's expenses might be unnecessarily increased.

Captured contraband cannot be appropriated, but must be brought in with the ship. Goods that are perishable or otherwise impossible to be brought in should be sold by the captors and

the proceeds delivered to the register of the prize court, and in case of necessity the prize itself may be sold, the proceeds being paid into court. If for any cause it cannot be brought in, it may be destroyed, the cargo and the ship's papers being saved if possible.

A cartel ship is used under a flag of truce for an exchange of prisoners, or for communication between the belligerents, and may be employed by any naval commander in the execution of his duties. She is regarded as neutral, and as such is held sacred. She should carry a white flag, together with her national one, but she must carry no cargo, and cannot be allowed to trade. She should carry one gun only, for use in signaling. Any abuse of her character would justify her capture.

We will now consider the proceedings in the prize court and their effect.

The adjudication must be made by the first admiralty court that obtains jurisdiction by a commencement of the proceedings. The court must be only of the captor's own nation, or of its ally in the war. Although in a suit *in rem*, a court, in order to exercise jurisdiction, is supposed to have the *res*, or thing in controversy, in its possession or under its control, a prize court may assume jurisdiction, though the prize may be lying in a neutral port, in which case it is deemed to be under the captor's control, and his possession is deemed to be that of his government.

The burthen of proof in all cases is on the captor.

Capture overrides all previous liens on the property, always excepting a bottomry bond on the ship and respondentia on the cargo, because these saved the ship's life. Were these liens not always respected, this means of saving ship and cargo would hardly be obtainable anywhere. When the cargo only is condemned, the ship being restored, the shipowner is allowed his freight, it being a lien on the cargo; but it will go to the captor if it is he that has carried the cargo to the place of destination. Subject to these charges, the captor takes the interest of the owner at the time of shipment without regard to any subsequent transfer or lien except as before mentioned.

It is important to bear in mind that mere capture does not transfer the ownership. Nothing can do this but the judgment of a competent court, the title meanwhile remaining in sequestration.

The law of the sea no single nation can change, and a prize court is therefore bound by the established rules and usages of maritime nations; but, under international law, the judgment of a prize court, whether correct or incorrect, is always held conclusive as between the parties, and a decision would be held valid under international law as construed by the captor's court. But although an unjust judgment of condemnation may bind the claimant, it does not bind the claimant's nation nor preclude it from demanding reparation from the captor's government, whose responsibility commences immediately on the rendition of a judgment in denial of justice.

No condemnation can be made after the war is ended. If peace finds the prize uncondemned, it must be restored.

Next, as to prize money: The established theory is that all prizes belong to the sovereign, so that the national government may lawfully restore the prize either before or after condemnation, and the captor would have no redress except by an act of the legislature. In the United States the prize money is distributable as Congress may direct.

There is no general rule as to the proportions in which prize money will be distributed among the respective claimants, this depending on the rules and usages of the different maritime nations. Our own prize courts follow in this respect the rules and usages of those of Great Britain. Under our act of Congress of 1800, when the enemy was in equal or superior force, the whole goes to the captors; if in inferior force, one-half goes to the United States and the other half to the captors.

It has been adjudged that when a naval officer not belonging to the capturing ship is on board only as a passenger, although acting in his official capacity, there is no rule that entitles him to share.

In the case of a joint capture, if the vessel claiming to share was in any degree instrumental in effecting the capture, this entitles her to share. In order to share she must have been at the least in sight before the surrender. In that case it will be presumed that she contributed to the capture either by adding to the fear of the enemy or by encouraging the captors; but this presumption is not made in favor of a privateer claiming only on the ground of having been in sight; for the reason that privateers are fitted out only for private gain and are under no obligations

to attack, whereas a war ship is always bound to do so, except when the enemy is in greatly superior force. So that the fact of a privateer being merely in sight is not supposed to encourage the captors or to add to the enemy's fear.

One other topic remains to be noticed—that of **Salvage on a Recapture**.

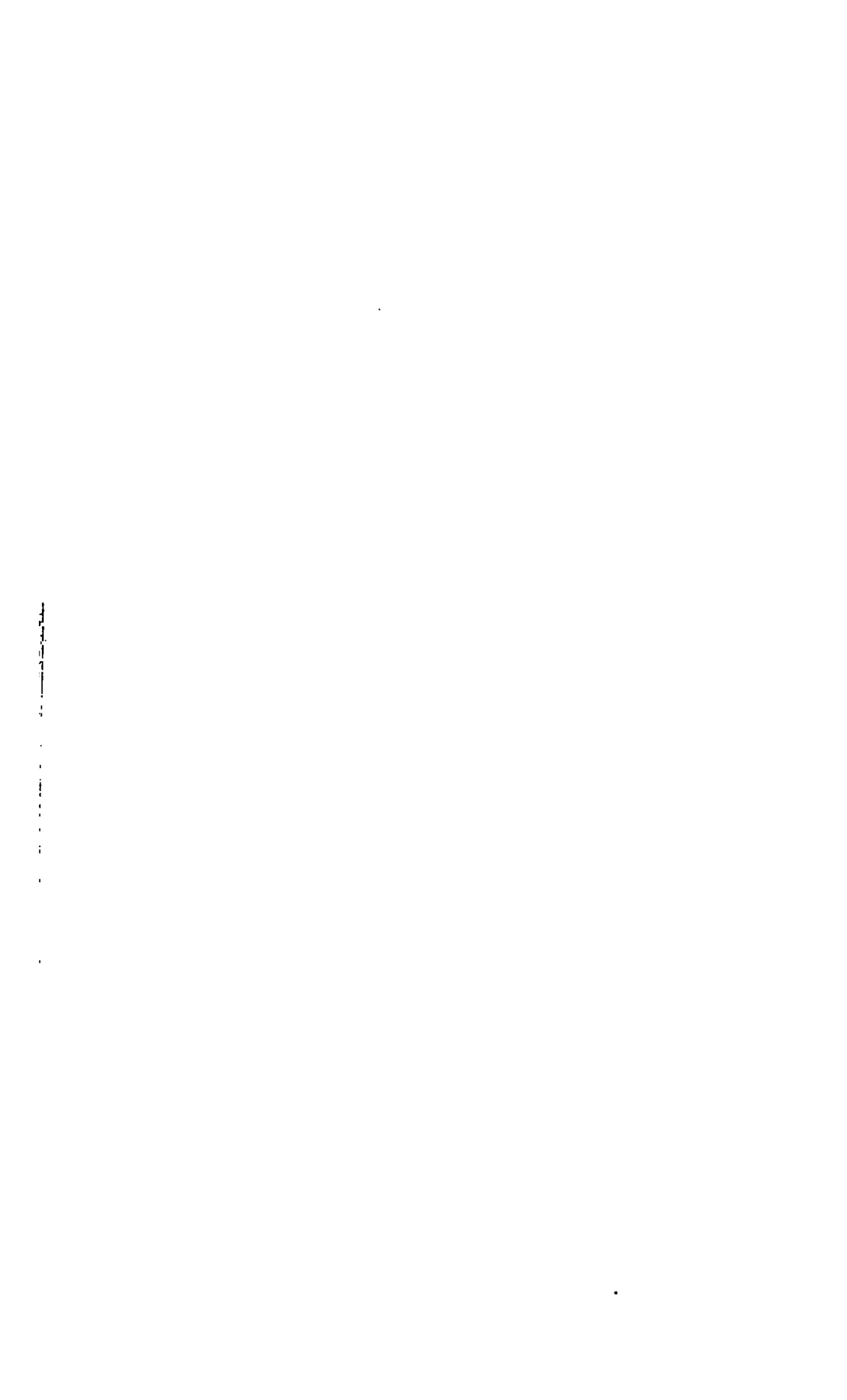
Among all maritime nations salvage is given to the recaptors, but as to the rate of salvage there is no uniform rule prevailing among them. Our act of 1800 (U. S. R. S., sec. 4652) specifies various rates of salvage according to the circumstances. It discriminates in favor of privateers. The reason of this discrimination is, no doubt, that a privateer is under no obligation to recapture, while a national ship in recapturing is simply doing its duty, for which officers and crew are being regularly paid by the nation.

When the recapture was not made until after the owner's title had been divested by the sentence of a competent court, there can be no restitution, and, consequently, no claim for salvage. But in the case of a recapture from pirates, restitution with salvage is always given, because there could never have been any valid change of title.

There is one case in which salvage is refused on a recapture. It is when the vessel had been unlawfully seized by the original captors. It is then presumed that there would have been a decree of restitution by the captor's own prize court, so that there never was any real danger of condemnation, and consequently the recapture not having conferred any real benefit on the owner, there is no ground for the payment of salvage. I should call this reasoning rather ingenious than satisfactory. In the early days of the French Revolution, however, this principle was not applied to captures by French cruisers, inasmuch as the French prize courts in those anarchical days were notoriously condemning without regard to the rules of international law, and accordingly in those cases salvage was usually decreed.

In concluding, I am tempted to make a remark, however paradoxical it may seem. It is this: That in these latter days a knowledge of certain branches of international law is of more importance to naval officers than to the diplomatists who represent us abroad, and for this reason, diplomatists nowadays are never compelled to make an instantaneous decision on any important

question. When a decision is to be made they have at hand all the books and authorities needed to enable them to arrive at a correct conclusion, and in all cases they can promptly receive by telegraph such instructions from their government as will free them from all responsibility. On the other hand, a naval commander may at any time be called on for instantaneous action that may possibly involve his country in war, with no time or opportunity to consult authorities, and in a place where no telegraphic communication with his government exists.



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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NAVAL RAIDS: A CURSORY EXAMINATION AND A
CONCRETE EXAMPLE.

By CAPTAIN C. F. GOODRICH, U. S. N.

Incident to a serious naval demonstration against the United States is the possibility that exposed points may be selected for sudden attacks, of which the object is rather (a) the destruction of ships either close to the coast or in port, or (b) damage to structures on shore with the alternative of heavy indemnity, than the winning of any military advantage. Such operations are, moreover, not restricted to occasions when a superior supporting force is in the neighborhood, but may be, as they have been, undertaken by solitary cruisers from a remote base. In discussing the aspects of raiding, it will conduce to brevity and clearness to separate the cases described and to take up first the simpler of the two. Our proposition may then be thus stated: "Given a reasonably complete command of our own water approaches, are such isolated raids to be apprehended, and, if so, how may they be best guarded against?"

Of the illustrations and precedents available, those are naturally the more valuable which relate to our own shores and, in point of time, lie within the period of steam propulsion. A study of such precedents will prove helpful in indications as to what should be done under somewhat similar circumstances, and may make clear certain principles applicable even when we are unreservedly on the defensive.

The literature of the raids by Confederate cruisers along our Northern seaboard is so full that we experience difficulty only in selecting what is most pertinent. In the following extracts attention is called to the mental side of the question, as reflected

in the alarms of the mercantile community; the pressure brought to bear upon the Government to appease these alarms; the real damage done; the measures adopted to put a stop to the damage.

As early as May, 1861, the Governor of New Jersey writes to President Lincoln that "The citizens of New Jersey residing in the southwestern part of the State and on the Delaware bay feel some anxiety on account of their defenceless condition and exposure to annoyance from privateers."

In July of that year the Jeff Davis, privateer brig, created a panic in the coastwise trade by her captures of vessels off Nantucket Shoals and Cape Hatteras. The Navy Department was inundated with reports of her activity, and requests for vessels to go in chase poured in from underwriters, private individuals and others. Such naval ships as were available were dispatched in pursuit, and private steamers were also engaged for this service. One telegram will suffice to show the Department's methods:

July 12, 1861.

Send any vessel you can find or hire after the privateer reported south-east of Nantucket.

Gideon Welles, Secretary of the Navy.

To Captain Breese, Navy Yard, New York.

In all, some eight or ten vessels were dispatched in pursuit, but without success. The Jeff Davis got safely back into the Confederacy after capturing four coasters.

Governor Andrew, of Massachusetts, addressed, on July 16, 1861, a long letter to the Navy Department upon the necessity of cruisers to protect coastwise commerce. Being typical of many others of like import from many sources, I quote some of its expressions *in extenso*:

In view of the exploits of Southern privateers within the past few days off our coast, a feeling of apprehension has come to pervade our mercantile community, surpassing anything which it has experienced during the progress of hostilities thus far. There is serious trouble among all our insurance companies, caused by the actual presence of a danger which they had confided in our naval efficiency to avert, and there exists throughout every branch of trade which is connected with our shipping an uneasiness which finds vent in anxious looks and words and expressions of indignation that the most stringent measures are not adopted to strengthen the blockade and to scour any privateer from our seas.

The Confederate privateer steamers Gordon and Mariner, about the same time captured the first the brig Wm. McGilvery and schooner

Protector off Hatteras, the latter the schooner Nathaniel Chase off Ocracoke Inlet. The privateer York took the brig B. T. Martin. These events brought to the Navy Department letters from the marine insurance companies of Philadelphia, beseeching more activity and better protection.

On the 12th of November, 1862, the Board of Trade of Boston addressed a communication to the Secretary of the Navy calling his attention to the defenceless state of that harbor and pointing out its liability to raiding by the Alabama, lately reported as not far distant, or by one of the rams then building in England for the Confederacy. They say: "It is believed by practical men that through Broad Sound (one of the two principal entrances to this harbor) a reckless and daring piratical ironclad steamer might enter without serious injury and lay our city under contribution. . . . In view of the foregoing facts, we beg respectfully to suggest that the new ironclad steamer Nahant (of the monitor class) now nearly completed by Mr. Loring, be allowed to remain in this harbor for its defence, at least till the necessary guns are placed in the several fortifications of this harbor and the pirate Alabama has been either captured or destroyed."

The following correspondence accentuates the pressure brought to bear on the Navy Department for local needs:

Albany, N. Y., September 16, 1862, 5.30 p. m.

(Received Washington, 6.30 p. m.)

Sir:—If there is anything in the statement of the New York World this morning in reference to rebel vessels, and I have information from a respectable source which goes to corroborate it, I am sure that the new ironclad Government steamer can be put to no use more important for all interested than by placing her at once in New York harbor, which I earnestly request.

E. D. Morgan, Governor of New York.

Hon. Gideon Welles.

Navy Department, September 17, 1861.

The steamer referred to is probably the New Ironsides, now at Philadelphia, where her presence is most earnestly requested by Governor Curtis.

The Galena and Monitor are guarding the entrance of the James River in anticipation of Merrimack No. 2. Under these circumstances it would seem to be impossible to comply with your request.

Gideon Welles.

On November 8, 1862, Governor Morgan writes the Secretary of the Navy urging that the Savannah be stationed in the North river, and that an ironclad be sent to New York.

November 12, 1862, the Boston Board of Trade wrote the Secretary of the Navy that the Nahant, just completing at Loring's yard, should be kept in Boston harbor, to protect it

against the incursions of the Alabama or other rebel vessels—the forts being but indifferently armed with 153 out of 475 guns allotted.

This letter was endorsed:

There is always some naval force at Boston, while other places on the coast, with the exception of Portsmouth, are not so favored. Were a cruiser to enter the harbor of Boston, which is very improbable, there is always a force to see to her. It can hardly be supposed that an armored vessel prepared for operations elsewhere should be detained at Boston and the expedition broken up under a remote apprehension that a hostile vessel might attempt to visit that place. G. W.

Albany, November 17, 1862.

I had just been informed that Rear Admiral Paulding was satisfied that the Savannah was unsuitable for the service specified. Accordingly you wisely determined that the Roanoke should be placed at the disposal of the Rear Admiral immediately on her completion as an ironclad. In the meantime you directed that one of the present ironclads be left to the harbor until the Roanoke is completed.

E. D. Morgan, Governor.

Hon. Gideon Welles.

Boston, November 18, 1862, the Boston Marine Society repeats the wish of the Board of Trade for an ironclad at Boston:

Telegram.

New York, November 20, 1862.

We respectfully request that the Passaic remain for the defence of this harbor until the Montauk is ready for that service.

E. D. Morgan, Governor.

Henry Barney, Collector.

Hon. Gideon Welles.

Telegram.

Boston, 2.40 p. m., February 2, 1863.

From last reports concerning the Alabama the intelligent Boston merchants believe it is not improbable that Semmes may make a descent on the Massachusetts coast, say at Provincetown, which is wholly unprotected, and suggest that an armed Federal vessel should be stationed there.

Jno. A. Andrew, Governor of Massachusetts.

Hon. Gideon Welles, Secretary of the Navy.

Commonwealth of Massachusetts,

Executive Department, Boston, April 27, 1863.

Sir.—I beg to request you to consider the importance of detailing immediately an ironclad vessel of war for the exclusive duty of protecting the harbors of the Massachusetts coast, and particularly the harbor of Boston.

(Here follows arguments as to extent and value of property exposed, etc.)

Not a single Federal vessel of war cruises in Massachusetts Bay for the protection of its coast and commerce, nor has the Federal commander at Fort Warren any authority to detain and examine suspicious vessels, or any steamer or cutter with which to execute such authority if it should be conferred on him; and the same want of protection is true of the southern Massachusetts coast, where through the Vineyard Sound 90,000 vessels have been counted as passing Gay Head in the course of twelve months.

. . . with those channels (Boston harbor) open to the commerce of the world, a daring commander of a single swift ironclad steamer like the Alabama, can undertake with a fair prospect of success, to suddenly run past the forts and appear before the city.

. . . . With our forts, therefore, so inadequately armed, the only efficient protection Boston harbor can have against the possible incursion of a single swift rebel steamer is by stationing here a Federal ironclad vessel which would be able to attack and sink such a rebel steamer when it should have entered the port.

. . . . I most respectfully but firmly urge upon your attention as a matter of right that such a vessel may at once be assigned to this duty. If it is a question of pecuniary consideration to the Federal government, I am ready and hereby offer to buy such a vessel from the United States and to pay for it immediately in cash.

The anxiety of the whole community for protection from sudden incursion by sea, the vast material interests at stake, and my own consciousness of the reasonable character of my request unite to induce me to ask an early reply to this communication.

John A. Andrew, Governor of Massachusetts.

The President of the United States.

The following day Governor Andrew addressed a letter of similar import to the Secretary of the Navy, in which he says:

I am after many days of careful exploration compelled to the conclusion that the only act of possible of immediate utility and likely to impart early relief to the public mind is to procure the assignment of an ironclad steam vessel, with its complete armament ready for any service to the separate defence of our principal harbor.

The same day he wrote to Senator Sumner to urge the Department to equip and station the Ohio at the mouth of the harbor at once, pending the arrival of the ironclad.

Navy Department, May 2, 1863.

Sir.— . . . Among the suggestions urged by you on the consideration of the Federal Government is one for an ironclad steamer to be stationed

at Boston. We have not, however, a vessel of this description that can be spared from other duty and appropriated to that object at this time. Nor, with due deference, do I think that such a vessel is the best adapted to the coast defence of Massachusetts and New England, although it might be more useful, perhaps, in the harbor of Boston, should a roving privateer or pirate make its appearance at that port. But the turreted vessels which we have, while admirably adapted for harbor defence and operations on the coast, are not vessels of speed, and therefore would not be efficient, except at a single point. It has appeared to me that to guard against the improbable but possible contingency of a hasty descent by one or more of these rovers upon some unprepared place upon the coast, it might be a wise precaution to have a fast cruiser stationed at Boston and always prepared for service. Such a vessel besides affording security for Boston and its immediate vicinity, would, on receiving intelligence from any place on the coast by telegraph or otherwise, proceed at once to the scene of the danger, and with a probability of capturing the invader.

For the extensive coast of New England such a vessel would be more efficient than one of the ironclads. We can at this time ill spare one of the fast cruisers for such a service, but it may be a wise and advisable precaution demanded by the great population and interests involved. The Department will therefore make it a point to have a cruiser stationed at Boston.

Your suggestions, made through Senator Sumner, that a battery be placed on the *Ohio* shall have immediate attention, and though we cannot fit her for cruising, she will afford additional security to Boston. . . .

Gideon Welles, Secretary of the Navy.

His Excellency John A. Andrew, Governor of Massachusetts.

June 19, 1863, the New York Harbor and Frontier defence Commission passed resolutions relating to New York harbor, sent to Secretary of the Navy through Senator Morgan.

Navy Department, June 26, 1863.

Sir.—In reply I would say that there are no ironclads at present available for service in New York Harbor. All now in condition for active operations are needed on our blockading stations, which are threatened from both without and within. The *Roanoke* is under orders to Hampton Roads, where her presence is deemed of importance.

Gideon Welles.

Hon. E. D. Morgan, New York.

On May 4th Governor Andrew renewed his request for an ironclad, and on May 7th Secretary Welles replied, "there is no vessel of that class at this time available."

It is impossible, in reading the letters and telegrams quoted above, not to admire the wisdom and firmness displayed by the

Secretary of the Navy. A weaker man could not have withstood the popular clamor arising in every seaboard town for local protection, but would have divided our too scanty forces and have made the less important points secure at the sacrifice of the larger, the vital interests at stake. Mr. Welles' contention was, in effect, that the harbors of New York and Boston were guarded by the vessels of the blockading fleet which stretched from Cape Henry to the Rio Grande, a surprisingly broad and sound strategic view, from which he appears never to have wavered. This view, the very essence of correct coast defence, stood successfully the test of years of war. Given fresh conditions not too unlike the old, it will still prevail. Yet to-day we hear on all sides a noisy demand for harbor-defence vessels and batteries of 16-inch guns on every salient.

That Mr. Welles should have consented to the placing of a cruiser in Boston and a monitor in New York must not be regarded as a surrender on his part of the military principles for which he did battle, but rather as a proof of the magnitude and volume of the cry for help from those who were in a position to somewhat dictate the form this help should assume. It was like the bending to the blast which saves the tree from destruction.

Whether, in the event of war in these days, a Secretary of the Navy can possibly be as independent in his action as was Mr. Welles, it is difficult to say. The question is of great importance to us, although it hangs rather upon the sociological development of the country than upon naval policy. Personally, I am disposed to fear that the powers of the press and the politician will, together, overbear the future Secretary and force him into abandoning, not the true faith itself, but its practice. It is incumbent upon all who seriously discuss the naval problems of the future to recognize the possibilities for evil which may, and doubtless will, flow from the source so clearly defined in these extracts from the history of the past.

I purpose illustrating by an example drawn from an event of the Rebellion the method of apprehending a raider, which it will be our duty to *avoid*, and thus incidentally and *per contra*, to point out the measures which seem better adapted to the end in view.

THE TACONY EPISODE.

The summer of 1863 was characterized by a raid which for boldness and success must long remain notable in naval annals. The narrative, most interesting and instructive, will first be briefly given, and then the lessons it contains will be pointed out with reference to the general question with which we began the study of this species of warfare.

In May of that year the C. S. S. Florida was preying on American commerce off Cape San Roque, Brazil, in the fair way through which must pass all sailing vessels crossing the equator in the Atlantic ocean. It may be remarked, parenthetically, that this point might with propriety have been guarded by one or more of our own ships. On the 6th she took the American brig Clarence. Second Lieutenant C. W. Read, of the Florida, then made a suggestion to his commanding officer in these words, "I propose to take the brig which we have just captured, and with a crew of twenty men to proceed to Hampton Roads and cut out a gunboat or steamer of the enemy.

"As I would be in possession of the brig's papers and as the crew would not be large enough to excite suspicion, there can be no doubt of my passing Fortress Monroe successfully. Once in the roads, I would be prepared to avail myself of any circumstance which might present for gaining the deck of an enemy's vessel. If it was found impossible to board a gunboat or a merchant steamer, it would be possible to fire the shipping at Baltimore."

This proposition was approved, and Read, placed in command of the Clarence, immediately sailed for the Chesapeake. He had but one gun on board—a howitzer. Arriving off the Carolina coast a month later he burned or bonded three American vessels. In the meantime he had become dissatisfied with the Clarence's sailing qualities. From his prizes he learned that a rigid examination was made of all craft approaching Hampton Roads, and that none were permitted to pass Fortress Monroe except those freighted on Government account. His scheme being therefore impracticable, he "then determined to cruise along the coast and to try to intercept a transport for Fortress Monroe and with her to endeavor to carry out the orders of Commander Maffitt, and in the meantime to do all the possible injury to the enemy's commerce."

On the morning of June 12th, when about fifty miles east of Cape Henry, he captured the bark Tacony, by hoisting false signals of distress that brought her within hail, transferred his crew and howitzer to her as being the faster vessel, and burned the Clarence. At the same time he burnt one schooner, the Shindler, and bonded a brig and a schooner. The latter was made into a cartel. She brought the Clarence's prisoners into Philadelphia, as well as the news of the Tacony's conversion into and presence as a privateer.

The Tacony then stood off shore into the track of the homeward-bound West India trade. On the 15th, being about 250 miles east of Cape Charles, she burned a brig. Thence she went toward Nantucket, where, on the 20th and 21st, that island being about northwest and sixty miles distant, she burnt a clipper ship, from London to New York, a bark and a Liverpool packet on the 22d in $41^{\circ} 3' N.$, $69^{\circ} 15' W.$ Until the 23d she seems to have remained in the neighborhood of George's Bank, burning fishing vessels to the number of eight. On June 24th she had reached to the northward into the track of vessels bound into Boston from Europe, where she bonded an emigrant ship and took the fishing schooner Archer, Portland, bearing west by north 110 miles.

Read says: "As there were now a number of the enemy's gunboats in search of the Tacony, and our howitzer ammunition being all expended, I concluded to destroy the Tacony and with the schooner Archer to proceed along the coast with the view of burning the shipping at some exposed harbor or of cutting out a steamer. Accordingly, on the morning of the 25th of June we set fire to the Tacony, and with the Archer stood in for the coast."

Learning that the revenue cutter Caleb Cushing was in Portland and that a staunch, swift propeller would remain there during the night he determined to run in and seize both. He entered the harbor unchallenged at sunset June 26th. His engineer expressing doubts as to his ability to start the engines of the steamer, and the enterprise demanding successful results before daylight, he abandoned the notion of taking the steamer, resolved to capture the cutter, and after getting from under the guns of the forts, to return and burn the shipping. Easily and quietly he boarded the Caleb Cushing and with her stood out to

sea. The wind, however, failed him toward morning of the 27th, so that he was readily overhauled by two large steamers and three tugs with United States troops on board sent out in pursuit. He set fire to the Cushing, took to his boats and at 11.30 surrendered to the Forest City.

On the other side we have a record of alarms seldom paralleled in our history. The telegrams to the Department began to arrive on June 13th, the day after the capture of the Tacony off Cape Henry, and poured in with little cessation during the succeeding fortnight.

The Secretary of the Navy telegraphed the commandants at Boston, Philadelphia and New York: "Charter or seize half a dozen moderate-sized, fast vessels; put on board an officer, a dozen men and one or two howitzers; send them out in various directions. Take any vessel that can be sent to sea within the next forty-eight hours." To Rear Admiral Lee, at Hampton Roads: "Send out anything you have available." Again, on June 24th, the Department telegraphed to the commandant, Boston: "Charter more steamers and send them out after the Tacony; all that can be sent in forty-eight hours. G. W." Phenomenal activity reigned in naval circles and every suitable vessel that could be had in any way was dispatched on the track of the Tacony.

The chase after the Tacony can best be described graphically.

The markings on the charts give the positions of the Tacony and of each of the vessels sent in chase at noon of each day. A sharp distinction must be drawn between those positions which are of official record and those which are only estimated. The former are beyond controversy. The latter must be taken as merely the best guesses made after careful study of the orders governing the movement of the vessels concerned and the cruising reports returned. The log-books of regular United States cruisers are alone available at this time. The reports of chartered vessels are generally devoid of all statements as to latitude and longitude. An occasional reference to the speaking of another ship affords the only check on the guessing. My readers must be content to take such estimates under the qualification mentioned. I feel confident that in most cases they are not very far wrong. Some vessels sent in pursuit I have omitted altogether from these charts, not feeling justified in hazarding my opinion as to their whereabouts. For the table of noon positions

of the naval vessels I am indebted to the courtesy of Lieutenant-Commander Rush.

It seems incredible that a sailing craft of only average speed should have cruised against our coastwise traffic in so successful a manner, and have enjoyed from first to last, a period of two weeks, complete freedom from interruption by the forty odd vessels, most of them steamers, sent in pursuit. The fact demonstrates afresh the difficulty of finding a ship on the ocean when her course and destination are unknown, and emphasizes the necessity, if practicable, of arresting her at the place of exit. The inference from the occurrence itself, supported by the evidence of the track charts, shows a misuse of the force employed in patrol. At times the *Tacony* must have been perilously close to her pursuers.

The *Blackstone* reported that she had twice been near the *Tacony*, but that the two vessels were concealed from each other, in one instance by the darkness of the night and in the other by the obscurity of fog. Thick weather prevailed. This episode answers affirmatively the first query of our opening, as to whether such raids are to be apprehended. It would be equally valid in the face of a hundred cases tending to prove the contrary.

To consider the individual instructions issued to the cruising vessels would consume too much time and bear little fruit, but a hasty glance over them reveals the lack of a well-defined scheme calculated to cover the ground in a thorough and efficient manner. Admiral Lee was restricted to the waters south of the Capes of the Chesapeake, but the commandants at Boston, New York and Philadelphia were apparently unhampered, for they sent vessels in any and all directions. In consequence, the ships cruised in a haphazard manner, large gaps were left in the patrol line, while at other points there was an undue accumulation of force. As a result, the *Tacony* was not apprehended. Had the task of searching been divided between the four bodies of ships, each with its own allotted ground to examine and protect, and had a central authority directed the movements of all, it is yet possible that failure would have occurred, still the chances of success would undoubtedly have been increased. That *Read's* party was finally captured is no excuse for her continued immunity from detection. The ships sent out rushed madly in all quarters, burnt up their fuel with all possible dispatch, broke down their engines and had to put back to port for coal and repairs. Less

activity in the fire-room and more expenditure of brain tissue in devising a consistent and simple scheme of patrol, assigning to each ship its geographical square to cover under reduced speed, or her due place in scouting line would have probably yielded better results. One is free to recognize the parallelism between this episode and the chase after the Confederate cruisers *Alabama*, *Florida*, etc. We were invariably sending ships after the latter and to the ports they had just quitted, and we were, of course, always just too late to catch the bird that had flown. The records show that no plan of guarding certain strategic points—where the streams of ocean commerce mingle or cross, and there affording protection to the sailing ships that must, of necessity pass through them—yet it is at these very points our merchant vessels were mostly captured and destroyed. Each captain went largely on his own judgment and measured the success of his cruise by the number of miles travelled.

Nothing is more clearly demonstrated by the *Tacony's* cruise than the need of some central control. And had the Government profited by the warning it thus received and established some such off-shore guard to its coastwise trade, the careers of the *Florida* and *Tallahassee* in the following year would have been marked by fewer burnings of American ships, while they might, indeed, have been brought to a sudden close. The *Florida* passed rapidly along our shores, did what damage she could, and then stretched over to the Azores. Some of us remember the excitement she aroused and our own share in the wild-goose chase after her. The *Tallahassee* in ten days burned, scuttled and bonded thirty-one vessels, and returned to *Wilmington* after an absence of twenty days consumed in the dash along the coast to *Halifax* and back.

Taking up the second of our initial queries, "How may such raids be best guarded against?" we must rely upon the principles already deduced as governing the operations of scouting, for they are equally applicable to the problem which now concerns us. The postulate, it is to be remembered, is our own reasonably complete control of our water approaches. The rules we have evolved call for scouts steaming at convenient speed in two lines, an outer and inner, separated by a distance equivalent to that traversed by an average vessel in twelve hours, so that the raider must cross one zone of daylight within sight of one or other of the patrol lines.

In this way our coasting trade would be hedged in and protected as effectively as possible, the occasional movements of the scouts to coaling and signal stations serving to guard the space included between the patrol lines and the beach. In addition, small cruisers might be placed at points, of which Provincetown is the type, ready to move in any direction on telegraphic summons to the relief of a threatened port.

HOW GUARD AGAINST RAIDS?

II.

The problem assumes a very different guise, however, when, the postulate being changed, we are thrown wholly on the defensive. In this case, our coasting vessels will have been withdrawn from the seas and our duty have been restricted to the attempt at warding off the attacks of single cruisers upon isolated and exposed points deficient in local defence. The question evidently hinges upon the completeness of the enemy's investment. If he be present in such overwhelming force as to contain our main fleet and in addition to establish an adequate watch over our fortified harbors, we shall be powerless on the water, at least, to oppose effectual resistance to the blows contemplated. Such points must then look to the army for shore works that will keep the enemy's lighter vessels off at harmless distance. These works need not be elaborate or heavily armed. Hasty earthworks and a few six-inch modern rifles, for example, will abundantly serve. As against landing parties, the regular or State troops will suffice. It is simply a question of the most profitable use of the means at hand. All points cannot be protected; some must be left exposed. The army must incur the obligation of selecting the sacrificial lamb.

Between the two extremes we have considered comes the quite probable mean, which may be thus defined: "Given to the enemy a great but not overwhelming naval superiority, how can we best guard against raiding?"

It will be wisest, in my opinion, to throw this burden upon the army entirely, for it will be difficult to spare any of our ships from their more important duties. Such a measure, however, would not be approved by public opinion, which, after all, rules in our land. The Navy Department would be unable to resist

the appeals from governors, mayors, chambers of commerce, boards of trade, insurance companies, and the politicians, who never lead and direct the general sentiment, but follow it at a short distance astern. In this world it is the expedient which control men's actions, not the intrinsically desirable—and popular clamor must and will be appeased.

In apportioning the means to the end, the first consideration is the size of vessels that the enemy can employ on raiding duty. This will be determined by the depth of the water approaches. If the towns are exposed, like Galveston, or if the harbors are deep and roomy, the cruisers of the enemy may be of the larger type. If the water be not deep, if the harbors be narrow and limited, or the towns back from the coast, the cruisers will be of the smaller type. Our admiral must select for his guard ships cruisers not less in power than those likely to be sent in by the enemy, assigning each to a certain district or division of the coast line. A *sine qua non* is a safe refuge behind stout shore works. Lacking this refuge, he may lose his ships by a descent in force. If each section of the line to be guarded were provided with two or more such shelters, the security of the patrol ship would be greatly increased, as it would always have one point within easy reach. Local conditions will govern, of course. The ideal combination is a swift cruiser of adequate force, a short patrol line, a central station, and harbors of refuge on each flank. In practice, much that is desirable will be lacking, and the best must be made of the actual circumstances. The possession on our part of an efficient system of lookout and signal stations connected by telegraph and telephone with the central post of the patrol will enable the latter to watch a comparatively wide stretch of coast.

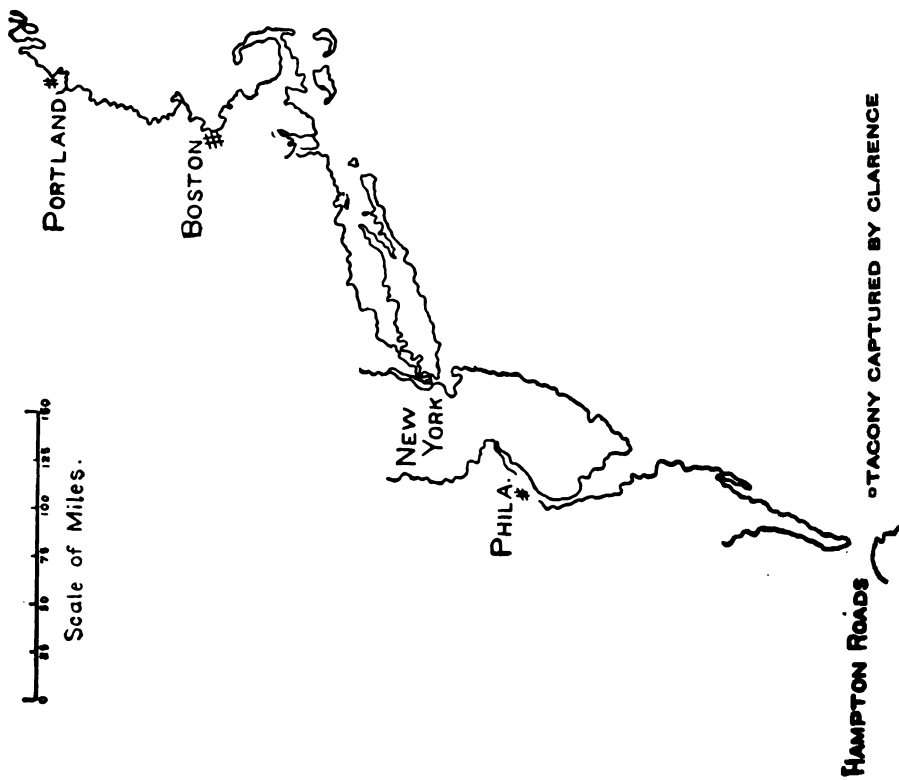
Vigilance and prompt action may prevent such raids as are contemplated, or catch the raider red-handed. More complete means of prevention and protection are barred by the conditions of the problem. When we shall have quickly detected the presence of the raider and have started at once on his tracks we shall have done all that our scanty resources in ships have rendered practicable. Success may not crown our efforts, and popular dissatisfaction will then be aroused against the Navy. Our indifferent reward will be found in the reflection that we have done the best we could and have failed because no other result was attainable.

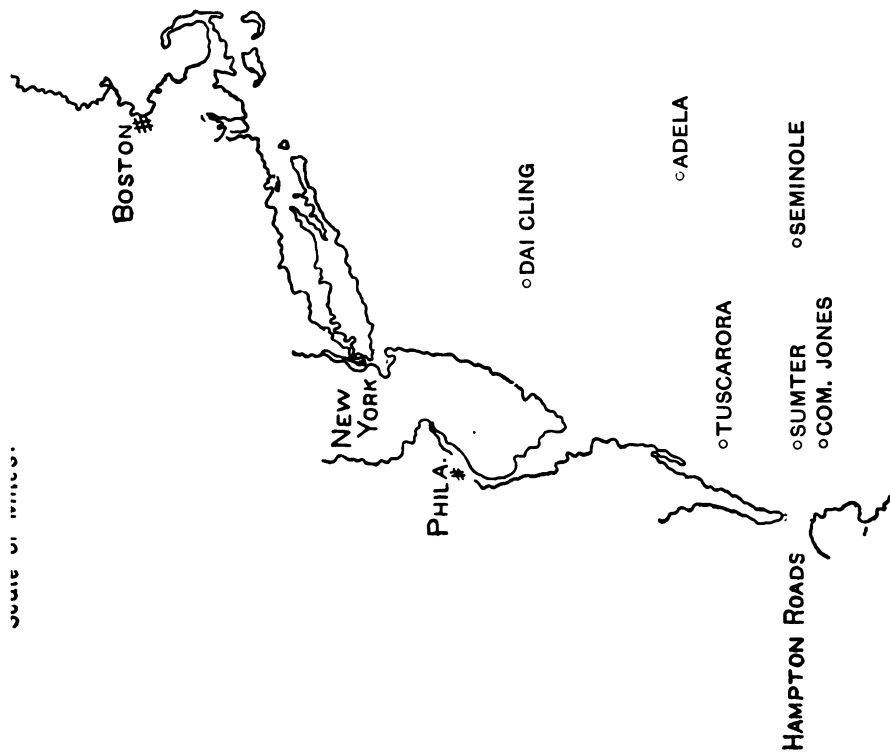
1863.—NOON POSITIONS ON JUNE

Name of Vessel.	Sailed From.	Date.	15th.	16th.	17th.	18th.	19th.	20th.	21st.	22nd.	23rd.	24th.	25th.	26th.	27th.
Adela.....	New York...	June 14th	37-59' 73-12	36-48' 75-23	36-37' 75-04	38-25' 74-41	Hamp- ton Roads.	37-09' 75-29	35-56' 75-30	35-59' 74-20	33-53' 76-33	33-26' 78-09	Port Royal.	Port Royal.	Port Royal.
Commo. Jones ...	Norfolk	June 14th	Off Capes of the Chesapeake, in sight of Cape Henry.			Off Cape Henry.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.	Norfolk.
Dai Cing ...	New York ...	June 14th	39-13' 73-48	37-19' 74-18	36-38' 74-43	Off Cape Henry.	Hamp- ton Roads.	New- port News.	New- port News.	New- port News.	New- port News.	New- port News.	New- port News.	New- port News.	New- port News.
Ethan Allen.....	Boston	June 23d	.....	.....	.....	.....	.....	.....	.....	.....	.....	21-44' 68-15	40-57' 66-26	40-53' 65-44	41-53' 65-40
Iron Age.....	Boston	June 25th	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Broke Down.	Broke Down.
James Adger	Port Royal...	June 26th	.....	.....	.....	.....	.....	.....	34-05' 76-25	Hamp- ton Roads.	Hamp- ton Roads.	Off Cape Hen- lopen.	Phila- delphia.	Reedy Island.	Off Cape Hen- lopen.
Kittany	New York ...	June 15th	.....	40-25' 72-45	39-35' 71-33	40-08' 69-33	40-26' 68-35	40-30' 67-34	40-45' 67-30	40-30' 67-00	40-40' 66-15	41-12' 65-12	41-24' 63-06	41-45' 61-43	42-36' 60-38
Marion	New York ...	June 16th	.....	.....	Off Sandy Hook.	40-00' 72-03	Off Sandy Hook.	Off Sandy Hook Bay.	Off Battery, N. Y.	Off Battery, N. Y.	Navy Yard.	Navy Yard.	Navy Yard, N. Y.	Navy Yard, N. Y.	Navy Yard, N. Y.
Montgomery	Boston	June 17th	.....	.....	.....	.....	.....	40-40' 71-13	41-12' 70-58	40-38' 69-09	41-17' 68-15	41-09' 69-27	41-09' 69-38	41-45' 69-08	41-05' 67-30
Sabine	New York ...	June 16th	.....	.....	.....	.....	.....	35-00' 64-58	35-51' 62-48	32-46' 62-10	31-51' 60-14	31-20' 59-20	30-21' 60-15	28-51' 61-40	27-37' 62-02
Seminole	New York ...	June 14th	37-01' 74-05	35-30' 72-15	36-37' 74-19	37-58' 72-58	36-54' 73-47	38-31' 75-00	.....	.....	.....	.....	.....	.....	.....
Shenandoah	Philadelphia.	June 26th	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	40-30' 72-25
Sumter	James River.	June 14th	Off Capes of the Chesapeake.	.....	37-05' 75-35	36-40' 75-50	36-45' 75-55	36-59' 75-44	Horse Shoal.	Off Capes of the Chesapeake.	.....	.....	.....	.....	.....
Tucaroza	New York ...	June 14th	37-35' 75-16	35-36' 75-29	34-35' 75-32	33-49' 68-10	35-02' 69-20	35-30' 71-30	36-32' 75-32	Off Cape Henry.	New- port News.	New- port News.	37-55' 75-07	39-09' 76-11	38-59' 68-14
Virginia.....	New York ...	June 15th	.....	39-20' 75-05	36-21' 70-02	35-02' 68-02	33-49' 66-17	33-45' 69-23	35-33' 70-00	36-55' 69-55	37-49' 70-23	37-49' 73-07	37-52' 73-49	39-08' 77-27	39-55' 79-20

Sunk by collision with the Gen. Meigs, June 24th.

June 12.





river, believing that if the fleet cut the wires on the high left bank they would be content with that and proceed, not supposing that there was a battery with mines on the other side also, which was a swamp.

My surmise was somewhat correct, for, had the battery station on the left bank been occupied, we should have been discovered, as at one time the Commodore Jones was high enough up stream to have seen into the station; she could have been destroyed moments sooner, but we were waiting for an ironclad. The orders given on board were distinctly heard by us, and it was in consequence of certain orders that the Commodore Jones was destroyed as she dropped back and over the mine.

The fleet very soon after (the same afternoon) retreated down stream, and did not return so high up the river again for more than a week, the importance of which will be seen further on. Many valuable articles from the wreck were picked up, especially official correspondence of importance to the Confederate government. The Captain's trunk, private correspondence, Bible, etc., were carefully packed up and sent at once to Major Mulford, of the United States flag-of-truce steamer.

The simple act of destroying the Commodore Jones was not in itself of so much importance as the destruction by torpedoes of many other vessels—ironclads, for example; but aside from its marking the first success of an electric system of torpedoes, it had another bearing.

On May 5, 1864, General Butler landed at Bermuda Hundred, guarded by the same fleet, under Admiral Lee, to which the Commodore Jones was attached. Admiral Lee lost no time in pushing on up the river with his whole fleet, for in a few days thereafter he was off Four Mile creek, where he witnessed the destruction of the Commodore Jones. On the 16th of the same month General Butler made his attack at the rear of Drury's Bluff, James river, and was repulsed by General Beauregard. That struggle was one of the hardest of the war. The trees and ground in front of the works were a sight to behold. There was many a moment when the result was doubtful.

Now, the object of pushing Admiral Lee's fleet, accompanied by transports, up the river at that time was believed in Richmond to be the assistance of General Butler in the attack on Drury's Bluff. Certain it is that there was nothing to prevent Admiral Lee from doing so but the torpedo defenses, and these, as already shown, compelled his retreat for the time. (Chapin's Bluff batteries were just below Drury's Bluff, but they would not have prevented the monitors from attacking both bluffs.) This was, of course, known at Drury's Bluff, and enabled several hundred of our best gunners to leave the batteries in front and serve the guns in the rear works against Butler.

If Admiral Lee could have sent a few ironclads to within sight of the Bluffs, the gunners stationed at the river batteries would have been retained here. Without them at the rear, General Butler could not have been repulsed, and Drury's Bluff, the key to Richmond, would have fallen that 16th of May, 1864.

Mr. Mallory, the Secretary of the Navy, in writing me after the war, uses these words: "The destruction of the Commodore Jones, the leading vessel of Admiral Lee's fleet, which was ascending the James river to co-operate with General Butler in the attack on Drury's Bluff, by causing the retirement of that fleet, undoubtedly saved Drury's Bluff, the key of Richmond." And in the same letter he adds: "I always

regarded the submarine department under your command as equal in importance to any division of the army."

Admiral Porter states that the man who fired the torpedo that destroyed the Commodore Jones was shot from one of Admiral Lee's boats. This is a mistake. He was still living in 1889. The man shot was a carpenter of no torpedo importance. He also says that the men captured were "very communicative." I am sure Admiral Lee thought they were, and that was just what I wanted. They were as good and true men as ever stepped in shoe leather, and had often been well drilled as to how much and what to say, in case of capture, for we were always much exposed. Had they been untrue, the fleet could have captured me, and also destroyed the backbone of the James river, the torpedo defenses, that same afternoon, and gone on up to the assistance of Butler at Drury's Bluff and, I believe, to the capture of Richmond.

I have often thought there was as much to be accomplished in working upon the credulity of the opposing force in time of war as in the use of your weapons, and that a special department might reasonably be organized for that purpose. This suggested itself to me during our war, because my torpedo department could not then be assisted by gun batteries at the several torpedo stations, and I was forced to all sorts of stratagems in order to work the defenses without such assistance. Think what might have been done with a highly nervous man like General Bragg, or even Sherman, for that matter, he himself having said, as we read: "The difference between Grant and me is, Grant don't care a d—n what the enemy is doing, and it just runs me crazy."

The personnel of war is not made up of Lees or Grants, but of comparatively very inferior substances, and the larger number of high officers could be easily thrown off their guard and made to vacillate, delay, and sacrifice their opportunities by annoying devices, plans, demonstrations, etc., well arranged and put forward by some such genius as would make a first-class detective, for instance. Of course, both sides could play at the same game; but as in the case of the torpedoes, the side that did not use it would be under a disadvantage.

A narrow escape was made by General Foster, General Negley, Lieutenant-Commander Cushing, and others when making a reconnoissance up the James river (I think in August, 1863), accompanied by the Monitor and another vessel. The Commodore Barney was ahead, and just above Atkin's Landing, when an electric torpedo of 1,800 pounds powder in five fathoms of water was prematurely exploded under her bows; but her headway took her under the falling mass of mud and water, and many men and much material were washed ashore. The Northern papers stated there were thirty-six men killed and wounded. The officer in charge of the torpedo station had the "buck fever," and fired the torpedo from sheer nervousness, and when I arrived at the station, half naked, from a bed of illness, he could hardly speak.

That was the lowest station on the river at that time. I was almost always near by, but on that day I was ill in bed with bilious fever, and rode to the station en déshabille, hoping to arrive in time. It was Cushing's sudden dash up the river that saved the situation. I should certainly have let the Commodore Barney pass on up and waited for the Monitor, knowing that at least the Barney could have been destroyed on her return. It is very singular that this occurrence did not give sufficient warning to Admiral Lee to enable him to avoid the destruction

of the Commodore Jones, and carry out the object of his expedition in May, 1864, when co-operating with General Butler in the attack on Drury's Bluff on the same river.

The failure to destroy the *Barney* made a most unfavorable impression at Richmond, and increased the howl of my opponents against the service I was engaged in, but I was always firmly supported by Mr. Mallory, who had the greatest confidence in the success of that means of warfare, and by our mutual friend, Captain John M. Brooke, who, later on, became Chief of Ordnance, and then the Torpedo Department feared no enemy in the rear.

In Admiral Porter's remarks as to the attack on the *Minnesota*, he says that "no serious damage had been done," and "the torpedo, which weighed fifty pounds, was not placed in contact with the ship, but was prematurely exploded." These statements are incorrect. There was a board of inspection ordered on the ship, and it reported much damage—certainly enough to justify the assertion that the torpedo was not "prematurely exploded," if we have no other evidence; but the contact was as well made as it is possible with any ramming torpedo known, even at the present time.

The report of the inspecting board, or of the commander of the ship, I forget which, showed that the torpedo exploded just abreast of a mass of shot and shell that the *Minnesota* had lately taken in to carry South. Moreover, the torpedo was too small—I thought so at the time. I could not get a larger steamer suitable for the purpose, and the one I used would not manœuvre with a larger torpedo down in an ordinary sea-way in such open waters as the mouth of the James river.

The attack, however, may fairly be called a successful one. It was the only attack of the kind during the war where any success was met with without the loss of the attacking party, and consequently the only one to prove the efficiency of the method. It must be considered that I had to explode my torpedo against perpendicular sides, whereas Lieutenant Cushing was lucky enough to find a vessel having an "overhang" (the *Albemarle*) under which he could not help getting his torpedo. He didn't require a contact with the sides.

As to being drawn into the hole in case I made one in the side of the *Minnesota* (as was the case with the *David* that sank with the *Housatonic*), I had provided for that by previous practice by direct ramming at an angle, always stopping the engine before striking, and practicing the engineer to go full speed astern as soon as he felt the blow, without waiting for orders. My torpedo struck the side of the *Minnesota* and exploded in just about one second after contact—an excellent result for the fuse of that day. The pole was shattered to pieces and the little steamer driven back forcibly.

When she backed off about fifty yards, and stopped to reverse and go ahead, her single cylinder engine caught "on the center," and there we remained—it seemed to me about forty years—under the fire of the *Minnesota*. The engineer, Mr. Wright (one of the bravest and coolest men I ever knew), got the engine free again, having to feel for the different parts in the dark. The little steamer was peppered all over with bullets. Several passed through my clothes, but we got off without any injury whatever. I then steered in the direction of Norfolk to throw pursuers off the scent, which proved successful. There was a steamer under the stern of the *Minnesota* that ought to have caught us easily. Several men were seen on her deck, forward, and those were fired at

rapidly to prevent their casting off their line, and she did not leave the Minnesota while in sight.

I believe there are those still living who, during the Civil War, regarded torpedo warfare as unworthy the higher qualities and duties of a naval officer. To such I would only ask: Whose judgment and foresight have proved the soundest? To those who believed it unfair and illegitimate I invite a careful study of all the circumstances attending the explosion of General Grant's mine before Petersburg, as compared with those under which the Commodore Jones was destroyed. Before making up my mind during our war to devote all my energies to the development of torpedo warfare, I thought seriously of the humanitarian phase of the question, but it did not take long to come to the conclusion that what we call humanity in war commenced after the surrender, excepting for the disabled, of course. Grant didn't think much of humanity when he used the mine at Petersburg, nor when he refused to exchange prisoners, knowing that the South was wholly unable to feed even his captured men; and to-day I believe that the more destructive weapons employed in wars, the less apt are wars to occur, and the soonest over. Long wars spread desolation and darken the earth. It would be far better to blow a whole army up in one mine and a fleet with another than that a war should last four years.

HUNTER DAVIDSON.

The Highflyer, a protected steel cruiser of the second class, was launched on Saturday, the 4th inst., from the yard of the Fairfield Shipbuilding and Engineering Company, Limited, Govan. The vessel is a sister ship to the Hermes, launched by the same builders on April 7, and illustrated and described on pages 470 and 497 *ante*. The two cruisers represent an improvement on the Juno class, of which the Fairfield Company built two—the Venus and the Diana. The dimensions of the Highflyer are: Length between perpendiculars, 350 ft.; breadth extreme, 54 ft.; displacement, 5,600 tons. The coal capacity is normally 550 tons, but provision has been made for carrying a greater quantity if necessary. The propelling machinery will consist of two sets of triple-expansion engines fitted in separate engine-rooms, each set having four inverted cylinders and four cranks. Belleville boilers will be fitted by the builders, and it is expected that the vessel will attain a speed of 20 knots.—*Engineering*.

The Angler, torpedo-boat destroyer, left Chatham Dockyard on the 3rd inst., for the final trials of her machinery, and the results obtained were satisfactory. The mean speed obtained for six runs on the measured mile was 30.559 knots. The official results were as follow for the three hours' full-speed trial: Draught of water, forward 5 ft. 11½ in., aft, 7 ft.; mean speed of ship, 30.372 knots; steam pressure in boilers, 212 lb. per square inch; revolutions per minute, 399.4 starboard, 398.3 port; mean indicated horse-power, 2,910 starboard, 2,910 port—total for the two sets, 5,820. The steering circle, stopping, and starting trials were also successfully carried out. The builders were Messrs. J. I. Thornycroft and Co.—*Engineering*.

REPORT OF TRIAL OF MARSDEN'S CORN-PITH CELLULOSE.

H. M. S. NETTLE, PORTSMOUTH.

Carried out on 18th January, 1898.

COFFERDAM.

The cofferdam was built of 15-lb. steel plating, 6 feet 6 inches high and wide, by 3 feet 3 inches deep. Its general scantlings are shown in the appended tracing. It was divided into three compartments by two transverse bulkheads. All rivet work was water-tight and the structure was well built. The middle compartment contained 67.58 cubic feet, the side compartments 35.52 cubic feet each.

THE CELLULOSE.

The cellulose was received at Portsmouth Dockyard on January 8, and was kept stored until the day of packing in the cofferdam, January 12. Its condition on opening the boxes was dry and excellent.

PACKING.

The middle compartment of the cofferdam was packed with 495 lbs. of cellulose in briquettes, at a density of 7.3 lbs. per cubic foot. The right-hand compartment was packed with 260 lbs. of cellulose, also in briquettes, at a density of 7.3 lbs. per cubic foot. The left-hand compartment was filled with 190 lbs. of cellulose, in the loose or natural condition, and condensed to a density of 5.35 lbs. per cubic foot. A plate cover with water-tight joints was then bolted on, and the cofferdam was set on board the Nettle for ballistic and obturation tests.

THE FIRING TRIAL.

The gun used was a 5-inch B. L. R., with the muzzle thirty feet from the face of the cofferdam. The projectile was a service common shell, weighing 50 pounds, with about $3\frac{1}{2}$ lbs. bursting charge and nose percussion fuse. The striking velocity was about 1,200 feet per second. The shell struck the cofferdam on the central line two feet from the bottom and burst in the dam just as its joint entered the back plate. The explosion was very violent and blew out the entire back of the compartment, carrying with it about one-third of the cellulose in the rear of the cofferdam, but leaving the forward two-thirds standing quite firmly in place (as shown on the tracings). The rents in the plating extended into the side compartments, but the cellulose therein was not disturbed. The cellulose blown out was scattered all over the deck, but although the shell exploded inside the dam, none of the cellulose was set on fire or even charred. As soon as the photographs were taken, a box-shaped front of steel plating was bolted on the face of the cofferdam and a stand-pipe about three feet long was fitted on its top. An ordinary fire-hose was connected to a pump, and the front filled with water. The water at once rose to the level of the shot holes, but the cellulose began to expand and no water appeared at the back. The tank was filled to the top of the stand-pipe, but still the back of the cellulose, even under this pressure of a head of 7 feet 6 inches, was not even damp. Finally,

after seventeen minutes from the time the water was put on, a hole about eight inches in diameter was washed out directly in line with the shot-hole. The rest of the material still remained firmly in a ring or arch around this opening. Experiments were then discontinued and the cofferdam slewed around with handspikes to get another photograph. Even this shaking did not dislodge the arches of briquettes.

This completed the firing trials. It is interesting to note that a head of water three feet above the head of the cofferdam (the height of which was 6 feet 4 inches) gives a mean head of 6 feet 2 inches on the cellulose. As the total exposed area of the compartment was 20.8 square feet, the total pressure withstood by the unsupported cellulose was about 3 lbs. by 1.44 by 20.8, 8,985 lbs., which is four tons. When it is considered that this weight was borne for four minutes solely by the expansive power of the cellulose, against the walls of the dam, the result appears most remarkable and highly satisfactory in every way.

THE BOILERS AND BULKHEAD DOORS OF THE CHICAGO.

The unarmored cruiser Chicago of the United States navy was one of the original vessels of the famous "White Squadron." She was launched in 1884, and on her trial trip she made 15 knots with 5,083 horse-power. It was decided about three years ago to make many changes in the Chicago, and these changes, which are almost completed, will convert her into a fast cruiser of 18½ knots, developing about 9,000 indicated horse-power. New engines, of course, were required, and they were built at the Brooklyn Navy Yard, as well as the boilers shown in our engraving. The Bureau of Steam Engineering adopted a combination of the cylindrical Scotch boilers and the sectional type. The engine-room is next the four Scotch boilers, then comes the blower room, then the six Babcock & Wilcox boilers. The Chicago will be worked under forced draught on the closed stokehold system when running at high speed. Our engraving shows a pair of the Scotch boilers, which are about 1,000 horse-power each. They are placed athwartships, and our illustration supposes the visitor to be in the stokehold looking at one pair of boilers, while the other pair is at his back. The Scotch boilers all make use of a common stack, and at the level of the protective deck the stack is crossed by heavy armor bars which preserve the integrity of the protective deck.

The Scotch boilers were built at the Brooklyn Navy Yard and are made of nickel steel, the sheets being 1½ inches thick and the heads ¾ inch thick. The mean diameter is 13 feet 8½ inches and the length 10½ feet. The three corrugated furnaces are 3 feet 5 inches in diameter and are all fired from the same stokehold. The length of the grate is 6 feet 8 inches. The outside measurement of the 417 tubes is 2¼ inches, and they are of a thickness of No. 10 Birmingham wire gage. The heating surface of the tubes is 1,770 square feet; the heating surface of the furnace is 134 square feet; the heating surface of the combustion chamber 166 square feet, and of the tube sheets 66 square feet. The total heating surface is 2,138¾ square feet. The grate surface is 68.33 square feet. The boilers are covered with magnesia covering. It is expected that the Scotch boilers will drive the ship at a speed



of 13 nautical miles an hour, and with the water-tube boilers it is expected that $18\frac{1}{2}$ nautical miles an hour will be made. The six Babcock & Wilcox boilers have a total heating surface of 18,000 square feet and 360 square feet of grate surface, making the total heating surfaces foot up 26,550 square feet and the grate surfaces 633 square feet. The bunker capacity is 920 tons. The steam pressure is 180 pounds per square inch.

The twin-screw engines are of the horizontal triple expansion type. The cylinders are $33\frac{1}{2}$ inches, $50\frac{1}{2}$ inches and 76 inches, the stroke is 40 inches and the engines make 120 revolutions per minute.

We now come to another interesting feature of the reconstructed vessels—the bulkhead doors. Lord Charles Beresford says: "It is a fact that upon the loyalty of the water-tight doors, when closed, and upon the assurance that they are properly closed, depends the power of a battleship to float when wounded by ram, torpedo or a gun. It has been authoritatively stated that the cause of the loss of the *Victoria* was that the water-tight doors were not closed, and it has been constantly proved to be impossible to close water-tight doors in an emergency, no matter how well disciplined and how gallant the ship's company may be. The system of closing the doors by evolution as to time invites an accident." Some very able experts contend that there should be no doors at all, and that the main bulkhead should be intact to the main deck.

To the layman, the number of bulkheads, doors, hatches and valves is extraordinary. Take the battleships *Indiana*, *Massachusetts*, or *Oregon*, for instance; they have 272 water-tight compartments, and the total number of water-tight doors and hatches is 354. The number of valves for ventilating, draining and flooding hulls, including sea-valves and pump-suctions, and excluding all valves for motive power and auxiliaries, numbers 294, making a grand total of water-tight doors, hatches and valves of 648. Valves are less important than doors and hatches, but when they guard a sluiceway, the passage of a ventilating pipe from one compartment to another, or a magazine flood-cock, they involve the integrity of the ship in an emergency. It is hardly possible to exaggerate the sudden turmoil and shock of a collision in a sea-way, accompanied by fog and blackness, perhaps within as well as without the ship, the wild upheaval and stampede of being torpedoed, or the strain and jar of modern battle; and it requires about 110 men, excluding officers, to bring the cellular structure of the ship into operation when needed in the type of ship to which we have referred, so there is no wonder that ships go down when they have their skin punctured below the water-line, as for instance the *Vanguard*, *Victoria*, *Blanco Encalada*, and *Elbe*.

Many experiments have been tried and systems introduced for the instantaneous closing of all the bulkhead doors in an emergency. We present some engravings of one of the most successful solutions of this problem—the "long arm system" of Mr. W. B. Cowles, of the Construction Department of the United States Navy. The cruiser *Chicago* as reconstructed is provided with an installation of this system. Mr. Cowles considered that a practically perfect system would be to tie together in assorted bunches the widely-distributed devices in a ship, by bringing the connecting strings from each device to a switch-board for each bunch and then assemble the switch-boards into one or more central stations, from which each device can be controlled by an operator, independently, and to arrange the devices as they are needed to

be operated in case of an emergency, so that this can be done with precision and full knowledge, from a point where the emergency can first be discovered. Arrangements should also be provided so that neither the emergency operation nor any other can harm the attendant or take control out of his hands, and all water-tight doors should be given an equal rank and precedence with the bulkhead of which when closed they form an integral part. The water-tight doors should be capable of closing under head or rush of water, and every bunker door should be able to close through coal. A system of this kind, placing its sole manipulation in the hands of one man, is comparable to the switch and signal tower of a railway.

There are two general schemes in the Cowles long arm system—the double line and the single line. The double line is more complicated and efficient, involving an operator at the central station. The single line



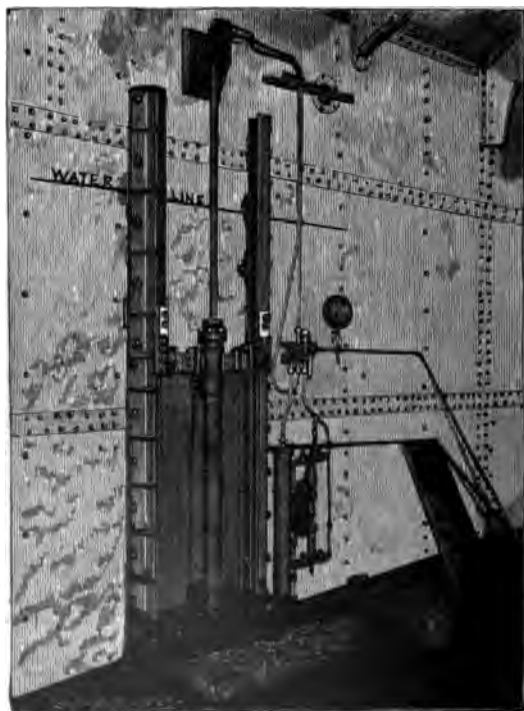
Bunker door with clear way open four inches.

answers in many cases where control valves and telltales are not required at the central station. Our illustration shows the single line system as applied on the United States cruiser Chicago.

The installation consists of eleven vertical sliding doors, all in the engine and boiler compartments, made of $\frac{1}{4}$ -inch steel plates with vertical angle iron stiffeners and with manganese bronze plowshares to force its way through coal. The power cylinders for each door are made of seamless brass tubes. The system is operated by a steam accumulator and duplex pump of the Worthington type. They are placed under the protective deck. The hydraulic main is 2 inches in diameter, reduced in suitable steps. The emergency gear consists of a power cylinder with a 4-inch stroke, operating the by-pass cock on the accumulator and a corresponding telltale and controlling valve in the conning tower, con-

ned by a $\frac{1}{8}$ -inch pipe and forming a "primary circuit." This circuit consists of two cylinders with their pistons and piston-rods connected by a double line of small piping. One cylinder, called the power cylinder, is connected with the device to be operated; the other cylinder, called the "telltale," is placed at the point where it is intended to operate the device. These two cylinders may be at any distance apart.

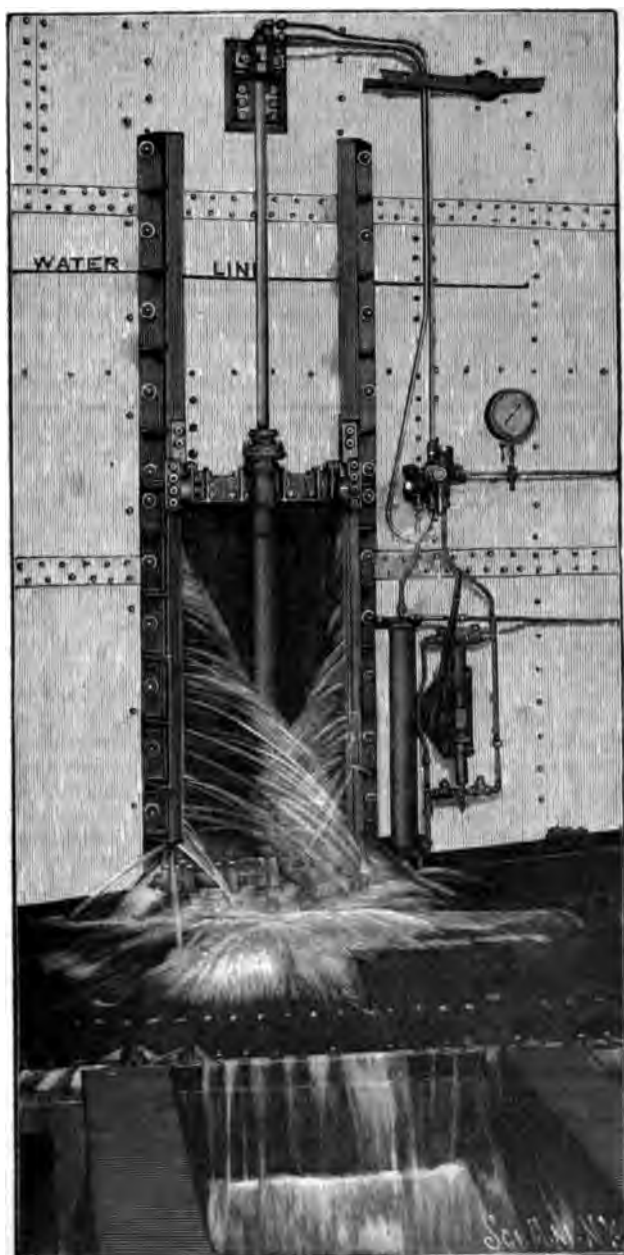
The double line of piping is so arranged that the pistons in the cylinders operate in exact accord. The power cylinder does the desired work, while the telltale cylinder reveals the position of the lower cylinder and consequently that of the bulkhead door. At each door is a so-



Bunker door under a head of water just before opening.

called "liberty valve," which can be started independently of the general system. Ingenious devices are provided to tighten the doors at side and bottom. One of our engravings shows the door under a head of water, with the tightening gear slacked up, and another, a bunker door, with all the tighteners in operation.

The side tighteners consist of traveling rollers held between a wedge track and a wedge bar, each of these latter being the full length of the door. The wedge track is secured permanently to the door, and the wedge bar rides with the door throughout its travel, except during the short tightening interval at the closing end of the stroke, within which



Bunker door under head of water, with tightening gear slacked up.

the wedge bar is held stationary on the guide, thus causing relative movement between the wedge track and wedge bar on the rollers. This movement presses the wedge bar out against the guide lip, and the wedge track, with the door and seating strip, in against the seat.

The doors are of $\frac{1}{4}$ -inch steel plate with $2\frac{1}{4}$ -inch by $2\frac{1}{4}$ -inch by $\frac{3}{8}$ -inch vertical steel angle stiffeners at side and with manganese bronze plowshare and top tightener castings stiffening, respectively, the bottom and top edges of the plate; the seating strips at top and bottom are of steel $\frac{3}{8}$ inch thick; the side seating strips, wedge tracks and wedge bars are of naval brass with Tobin bronze rollers $1\frac{1}{2}$ inch diameter by $1\frac{1}{2}$ inch long. The interlocking toes, pins and rollers are of steel, with adjustable manganese bronze stop-plates and fish-plate brackets. The wedges set in the plowshare are of steel, removable, and all parts of the door are screwed together throughout in such a manner that corrosion cannot affect the screws and so that any part may be renewed without injuring any other part. It should be noticed that the side edges of the door, outside of the stiffening angle, are flexible. When the tightening gear is free the door has $\frac{1}{8}$ inch play in its guides, both side-tips of toes are easily ground and pressed down, and fall to the floor between the webs and seat.

ADDITIONS TO THE NAVY IN 1897.

The year now closing has been one of considerable activity in naval work, and although the tonnage and power of vessels actually floated falls short of that of some preceding years, the cause is easily explained, and is temporary. The engineering dispute has delayed the work in private yards, and also in the dockyards—two more battleships would have been floated had the stern frame and stem, etc., been machined and delivered in time, the under-water fittings completed, and the propeller-shaft tubes bored. But while the tonnage floated is not so great as in some previous years, there has been continued recognition of the need for sea power, and thus the Admiralty have been liberal with their orders and assiduous in seeing that the work is expeditiously done. We have already recorded the expansion of the original navy programme for the year; all the vessels have been ordered except four armored cruisers, which will probably be given out early in the year. Meanwhile we content ourselves with a consideration of the warships built and tried during the year.

There have been 45 warships constructed in 1897 for British and foreign powers, and these in fighting trim represent a value of 6,617,700l.; while in the previous year the total value was 10 $\frac{3}{4}$ million pounds. This decrease is largely due to only one battleship being floated, whereas in last year's total there were included six of great size, four for Britain and two for Japan. Thus the tonnage in 1897 was only 96,786, against 155,849 tons in 1896; and even the latter was not a record, as the total in 1892 was 161,596 tons, although the average for the first six years of the decade is not over 100,000. The collective horse-power of propelling machinery for all warships, however, does not show the same falling off, aggregating 331,050 indicated horse-power, against 377,981 indicated horse-power, due to the inclusion of a large number of torpedo-boat destroyers. As in the past year, one-third of the tonnage completed was for foreign governments, principally Spain, Japan, China, and the

South American republics. The totals just given are accounted for as follows:

—	Number.	Tons.	I. H. P.	Value of Ships Completed.
Dockyard.....	4	31,885	47,000	1,752,700
Private yards (H. M. S.).....	22	34,111	163,400	2,385,000
" " (foreign).....	19	30,790	120,650	2,480,000
	45	96,786	331,050	6,617,700

In the previous year the foreign tonnage was 47,364; the horse-power, 118,364 indicated; and the value, when completed, 3,059,000*l.*; so that there has only been a decrease in tonnage. This is explained when it is recalled that instead of battleships costing 65*l.* per ton, a greater number of destroyers of 200*l.* per ton are included in the list.

The work of the Royal Dockyards does not bulk so largely as it might have done: two battleships are almost ready for launching. These, if they had not been delayed by the strike, would have brought the total quite up to the average, which for the preceding seven years was about 50,000 tons, against 31,185 tons for this year; while the average output for the navy from private yards is about 39,000 tons, against 34,111 tons for this year. But when it is recalled that the Royal Dockyards are so largely for repair, and especially for recuperative work in war times, the output has not the same significance; the interesting point is that there are in process of construction, including all vessels ordered and not yet tried, warships aggregating 355,620 tons and 766,800 indicated horse-power; at the end of last year there were completing, and under construction, vessels of 284,660 tons and 625,500 indicated horse-power, so that apparently there is more work now; but the rapidity of construction at the Royal as well as private dockyards will soon make a material reduction in these totals. The problems of design involved in this great fleet can only be guessed at; but the mere figures themselves suggest the work undertaken by Sir W. H. White, K. C. B., the Director of Naval Construction, and by Sir John Durston, K. C. B., the Engineer-in-Chief. Of the vessels building, 20, of 145,295 tons, with engines of 218,000 indicated horse-power, are in course of construction at the Royal Dockyards, where some 22,000 or 23,000 men are employed. The difficulties of management are great, at a time when labor is more or less in open revolt throughout the country; and the fact that there has been no real indication of cessation of work is due to the efforts of the Director of Dockyards, Mr. James Williamson. We give in the appended table the number and tonnage of the ships built for the navy in each year of the current decade:

PRODUCTION OF BRITISH NAVY SHIPS, 1890-97.

Year.	Dockyard.		Private Yard.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.
1890	8	22,520	13	42,475	21	64,995
1891	8	68,100	10	39,150	18	107,250
1892	9	50,450	13	90,750	22	141,200
1893	9	32,400	5	1,910	14	34,310
1894	8	26,700	19	4,825	27	31,525
1895	8	70,350	22	66,412	30	136,762
1896	9	71,970	26	36,515	35	108,485
1897	4	31,885	22	34,111	26	65,996
Total.	63	374,375	136	316,148	199	690,523

The vessels built for the British navy have already been described in *Engineering*, and here it is only necessary to mention them. From the Portsmouth yard there was launched the Canopus,* an improved type of Renown, differing only from the Magnificent class in having Belleville boilers and a slightly thinner although specially hardened armor, which so reduce the displacement as to enable the vessel to pass through the Suez Canal and steam into some of the harbors in the East with limited depth of water. The Canopus is 390 ft. in length, of 74 ft. beam, and at 26 ft. draught displaces 12,950 tons. Her engines, being built by Messrs. Scott, of Greenock, are to develop 13,500 indicated horse-power with natural draught, giving a speed of $18\frac{1}{4}$ knots. She has the same armament as our best ships. The Andromeda, the next ship in point of size launched from the Dockyards, is a cruiser of 11,000 tons, built at Pembroke, and belonging to the Diadem or Niobe class.† Her engines of 16,500 indicated horse-power are by Messrs. Hawthorn, Leslie and Co. The first of the class, the Diadem, will proceed on her steam trials in January, and much interest is attached to them, as the Belleville boilers are fitted with economizers in the up-take. The feed passes through the pipes of the economizers before entering the main tubes, and experiments with separate boilers give promise of a much higher efficiency than with the ordinary Belleville boiler. The Diadem is the first ship with these improved boilers to be submitted for trial. The Vindictive is a fleet cruiser especially strengthened for ramming, and armed for a long, stern chase.‡ She was built and engined at Chatham, and belongs to the same class as the Arrogant, the result of whose trials are recorded in our table. The fourth ship on the Dockyard list is the Pomone, launched at Sheerness, and fitted with engines by Messrs. Penn, of Greenwich. The prototype of the class was the Pelorus, described in *Engineering*, vol. lxiii, page 385. Devonport has not launched any vessel, but good progress has been made with the battleship Ocean. The output in tonnage from each of the five Royal yards is given below:

	1896		1897		Eight Years.		Average.
	No.	Tons.	No.	Tons.	No.	Tons.	Tons.
Portsmouth	3	29,360	1	12,950	13	121,635	15,204
Chatham	1	14,900	1	5,800	12	100,330	12,541
Pembroke	1	14,000	1	11,000	9	78,915	9,864
Devonport	2	11,700	—	—	16	52,500	6,562
Sheerness	2	407	1	2,135	13	20,995	2,664

It is scarcely necessary to enforce the point that a very large amount of the work of the Dockyards is in connection with the trials of new ships, and repairs and overhauls for re-commission, etc. The extensive fleet of the British navy involves a very heavy expenditure under this head; this year it has been greater than usual, owing to the Review, and to the fact that as new ships could not be completed in time to relieve the ships abroad, others had to be overhauled for the service. In this

* See *Engineering*, vol. lx, page 132.

† See *Engineering*, vol. lx, pages 77 and 83; vol. lxi, page 538, and vol. lxiii, pages 278 and 374.

‡ See *Engineering*, vol. lxi, page 71.

OFFICIAL TRIALS OF BRITISH WAR SHIPS, JANUARY TO DECEMBER, 1897.

Name of Ship.	Type.	Shipbuilder.	Makers of Machinery.	Coal Consumption Trial, 30 Hours.			Natural Draught.		Full Power.	
				Indicated Horse-power.	Speed.	Coal per Indicated Horse-power per Hour.	Indicated Horse-power.	Speed.	Indicated Horse-power.	Speed.
Jupiter	First-class battle-ship	Clydebank Comp'y	Clydebank Engineering and Ship-building Company (Thomson)	6,198	knots 14.1	lb. 1.51	10,248	15.8	12,475	18.4
Mars	Ditto	Laird	Laird	6,039	14.4	1.93 (Coal small at times.)	10,209	15.96	12,483	17.7
Hannibal....	Ditto	Pembroke Dock'y'd	Harland and Wolff	6,124	14.6	1.78	10,357	16.3	12,138	17.6
Caesar.....	Ditto	Portsmouth Dock-yard	Maudslay	6,309	14.8	1.93	10,638	16.7	12,653	18.7
Terrible	First-class cruiser	Clydebank Comp'y	J. and J. Thomson (Clydebank)	18,500	20.96	1.71	25,648	22.41		
Doris.....	Second-class cruiser	N. C. and A. Company	N. C. and A. Company (Vickers)	4,933	16.5	1.47	22,370		9,878*	19.7
Isis.....	Ditto	London and Glasgow Company	London and Glasgow Company	4,925	17.5	1.6	8,208	19.8	9,840	20.1
Arrogant....	Ditto	Devonport Dock'y'd	Earle's Company	7,624	17.8	2.1	10,290	19.6		
Illustrious..	First-class battle-ship	Chatham Dockyard	Fenn	6,155	14.5	1.77				

* N. D. and F. D. trials in 1896.

The above list is exclusive of torpedo-boat destroyers, tugs, shallow-draught steamers, and other small craft.

way several ships have been largely renewed, amongst the number being the Mercury, Porpoise, Arethusa, Mohawk, Leander, Barracouta, Swallow, Hotspur, Raleigh and several others.

The British ships built in the private yards do not call for special note. The Europa and Niobe built at Clydebank and Barrow, are of the same class as the Diadem already referred to; and the Pegasus and Pyramus built by Palmer, and the Perseus launched from the Earle Company's yard at Hull, are of the Pelorus type. The other vessels on the list are mostly torpedo-boat destroyers—the Fairfield Company having launched the Gypsy, Fairy, and Osprey; Palmer's Company, the Flying Fish, Fawn, and Flirt; Laird Brothers, the Panther, Seal, Wolf, and Express, the latter exceptional in being a 32-knot vessel, while all the others are 30-knot craft. From the Barrow works of Messrs. Vickers, Sons and Maxim there was also launched the Leopard; Messrs. Doxford launched the Violet and Sylvia; Messrs. Hawthorn, Leslie and Co., the Cheerful; while Messrs. Thornycroft also added to the number, which further includes a few gunboats. But after all, the chief interest in these destroyers is the result of their speed trials, and we are able to give a list which shows the power, speed, and coal consumption of all the boats of the class which have passed through official trials this year. This table scarcely calls for comment: but it will be seen that for 30 knots the power has varied from 6,606 to 5,654 indicated horse-power; but as a rule, 6,200 is about the average. The best speed got was with the Fairfield boat, 30.674 knots. Messrs. Palmer have been very successful with these craft, although the coal consumption seems higher than with some of the others. There is in this respect remarkable variation. Perhaps it may be well to state that Laird Brothers adopt the Normand type of boiler, Thornycroft and Fairfield the Thornycroft type, and Palmer the Reed type. These have all been illustrated in *Engineering*. It may here be remarked that the Clydebank Company have, during the year, passed through their trials several Spanish boats.*

We also give in tabular form the official results of the trials of other ships. The first four ships and the last on the list are alike as regards design—they belong to the Magnificent class of battleship. The cylinder dimensions, too, are the same, so that the coal consumption may be fairly compared, although it may be that the variations in the draught of the ship vitiate any true comparison of the speeds realized for the powers given. All these ships, like so many of their predecessors, have easily attained on trial the results anticipated in their design. The Terrible was, as is now world-wide known, fitted with Belleville boilers, as is also the Arrogant. These two are the only vessels on the list fitted with water-tube generators.

As to the foreign vessels, Sir W. G. Armstrong, Whitworth, and Co. launched the cruiser O'Higgins, of 8,500 tons and 16,000 indicated horse-power, for Chili; the Hai-Tien, of 4,500 tons and 17,900 indicated horse-power, for China (see page 751 *ante*); the Takasago, of 4,160 tons and 14,750 indicated horse-power, all remarkably fast steamers; and the two Norwegian battleships, Harald Haarfarge and Tordenskjold, of 3,500 tons and 4,500 indicated horse-power (page 62 and 419 *ante*). The Clydebank Company launched four torpedo-boat destroyers for the Spanish government, the first of which was illustrated in the first number

* See *Engineering*, vol. lxiii, page 19.

of this year. Messrs. Laird, of Birkenhead, completed a training-ship of 1,270 tons and 1,000 indicated horse-power, for the Argentine navy, and Messrs. Yarrow built several torpedo-boat craft, principally for South American republics.

OFFICIAL STEAM TRIALS DURING 1897 OF TORPEDO-BOAT DESTROYERS.

Ship.	Builder and Engines.	Description of Trial.	Indicated Horse-Power (Three Hours).	Speed (Three Hours).	Coal per Indicated Horse-power per Hour (when measured).
Quail	Laird	Speed	6049*	30.104*	
Thrasher		"	6003†	30.031†	
Earnest		Coal con.	6266	30.047	2.41
"		Speed	5931	30.137	
Griffon		Coal con.	6268	30.019	2.53
"		Speed	6081	30.111	
Panther	Thornycroft.	Coal con.	6606	30.142	2.43
"		Speed	6488	30.138	
Fame		Coal con.	5912	30.155	2.595
"		Speed	5852	30.168	
Foam		Coal con.	5846	30.093	2.205
"		Speed	5654	30.184	
Mallard	Palmer.	Coal con.	5746	30.201	2.08
"		Speed	5905	30.115	
Star		Coal con.	6197	30.103	2.64
Whiting		Coal con.	6254	30.167	2.76
"		Speed	6315	30.209	
Bat		Coal con.	6209	30.229	2.59
Crane	Fairfield	Speed	6199	30.129	
"		Coal con.	6428	30.138	
"		Speed	6267	30.347	
Chamois		Coal con.	6265	30.396	2.42
"		Speed	6339	30.221	
Osprey		Coal con.	6588	30.674	2.58
Zebra	Thames Maudslay	Speed	6412	30.427	
		Speed	4816†	27.003†	

* Consumption trial, December 11, 1896.

† Consumption trial, December 14, 1896.

† 27-knot boat.

HIGH EXPLOSIVES AND MODERN WAR-VESSELS.

The old battleship *Resistance* has at last come to the end of her somewhat chequered career, and her 4-inch iron plates have recently been stripped off for service as targets on the excellent ground at Whale Island. She has been riddled with ordinary projectiles of every calibre, torn to pieces between decks by high-explosive shells, and sunk by torpedoes on more than one occasion, having been subsequently raised for further experimental practice upon her hull. A vast number of points have been conclusively settled during the course of the experiments

which have been made with her. The futility of ordinary light armor as a preventive to the penetration of the smallest armor-piercing projectiles, even when protected by a backing of several feet of teak or oak timber, has been plainly shown. The great destruction which would be effected upon the upper decks by the smashing of the superstructure and boats thereon in action, has also been illustrated by experiments with dummies; whilst the value of a thick stratum of coal in bunkers along the ship's side has been thoroughly tested; and, lastly, the awful havoc which would be wrought between decks by the bursting of shells filled with high explosives, has been exhibited with appalling distinctness.

The first of these important lessons has resulted in the substitution of carburized armor plates for ordinary steel shields to protect all the heavy and medium gun positions in recent war vessels; the second, in the covering over of the upper deck battery at the sides with plating for some distance, and the stretching across the open space thus left between of a stout steel wire netting to catch splinters; and the third, in greatly multiplying the number and increasing the size of the coal bunkers along the ship's sides, from the main deck down to the bilge. The fourth lesson, however, remains only as a terrible, incontrovertible fact, which cannot apparently be got over. It is to this fact that we allude now.

We would invite an inspection of the hull and between decks of the *Resistance* in order to emphasize the remarks which we are about to make. No very heavy gun has been employed in negotiating the destruction of the helpless hulk; but 9.2-inch projectiles have passed through her from side to side, just as though she was so much putty, and even 6-inch armor-piercing shot have traversed her from stem to stern; the wrought-iron armor plates being torn off, and the skin of the ship's side and bulkheads being swept away as though they consisted of brown paper. Then the between decks is a sight never to be forgotten—framing, splinter screens, partitions, and bulkheads have been rent into fragments by the bursting of the high explosive shells, whilst grim splashes of a yellow substance that has marked the places where shells have bursted outside the plating betoken the character of the explosive employed.

It is now an acknowledged axiom that high explosives will be employed in shells. Whether naval officers object to carry them on board ship or not, they will in future be the principal ingredient by which shells are filled for coast and siege purposes; and already the nature of high explosives to be used as a service bursting charge for high-angle howitzers in coast and siege batteries has been practically determined.

After exhaustive trials, all inventions in this direction, except wet gun-cotton and lyddite, have been discarded. A satisfactory high explosive has been defined as fulfilling the following conditions: It should be safe in manufacture, store and transport, and stable under service conditions. It should be of a convenient form for filling shell, and safe to manipulate in the process. It must be capable of standing the shock of discharge in high velocity guns, and must, on striking, detonate with violence and certainty, and without the aid of any dangerous fulminate. The explosive should be capable of having its sensitiveness increased or diminished as occasion may require, and a shell, when filled with it, should not detonate when hit by another shell. Of those high explosives experimented with, the two coming nearest to the standard are wet gun-cotton, which has been adopted by at least one

European power, and lyddite, which is used in our service. Wet gun-cotton will not detonate in a shell struck by another shell, and in this respect is more satisfactory than lyddite; but gun-cotton, to produce its best effect, must be compressed into discs to fit the interior of the shell, and the shell must therefore be made in two parts and screwed together—a source of weakness and possible danger. Dry cotton and a fulminate are, moreover, required to detonate it. Hence lyddite, to which none of these objections apply, will probably be adopted as the high explosive of our service.

Such being the case, it is interesting to note the character and appearance of lyddite. Under the name of picric acid it has long been known. Picric acid is a nitro-substitution compound obtained by the action of nitric acid on a variety of substances; for example, indigo, silk, acaroid, resin, etc., but on the commercial scale the substance now generally acted on by the nitric acid is carbolic acid, and the equation of the process is simple, viz.:



Picric acid may, as written above, be regarded as a picrate of hydrogen, which latter element can be displaced by a metal to form an ordinary picrate—for instance, picrate of potassium, $KC_6H_2(NO_2)_3O$. It is a crystalline substance of a brilliant yellow color, and is intensely bitter to the taste. It burns with a very smoky flame. It is largely used as a dye, or constituent of dyes, and has not been usually considered as an explosive. Nor, indeed, does it usually behave like an explosive under ordinary circumstances, though under special conditions easily produced, it is capable of developing its now well-known formidable explosive properties. It may be burnt away in an unconfined state in considerable quantity without explosion, but the mere contact of certain metallic salts or oxides with picric acid in the presence of heat develops powerful explosives which are capable of acting as detonators to an indefinite amount of the acid, wet or dry, which is within reach of their detonative influence.

Lyddite has proved to be a fairly stable compound, and safe in manufacture, store and transport. High temperatures abroad, or in ships' magazines, do not affect its condition. When carefully packed into shells it does not "set back" like the nitro-glycerine in dynamite, on the shock of discharge, and so interfere with the "exploder," or create a condition of extreme danger, from the likelihood of a premature. Several accidents have occurred during the firing of shells charged with lyddite, from this last mentioned cause, viz., the projectile prematurely exploding in the bore of the gun. But in the majority of cases the causes of the disaster were traced to faults in the shell, and were not due to oversensitiveness of the lyddite. Shells to contain it are now made of the best forged steel, which minimizes the prospect of prematures. The action of a powder fuse will not detonate lyddite, hence an exploder containing a few ounces of a safe and stable explosive is employed. It is inserted in a hole drilled centrally in the charge. The actual nature of the exploder used by the War Department is kept secret, but many metallic oxides and nitrates will detonate when brought into contact with picric acid at a high temperature, and this fact has probably been taken advantage of by the chemical department.

Clearly, then, the high-explosive shell has a very marked future before

it, for artillery fire or active service; and, as foreign governments have gone even further than we have in the development of this terribly effective projectile—for one European navy, at least, has already introduced the melinite shell into its magazines on board ship—we must be prepared for attack with high-explosive shells in the next naval action, not only from shore batteries, but from the enemy's vessels.

This is a serious outlook. Take the cases of the *Majestic*, *Powerful*, or *Diadem* types. Probably the 6-inch Harveyized steel armor plates upon the 6-inch gun casemates of these vessels would break up or explode outside the majority of high-explosive shells with which they might be attacked, and the side and barquette armor would certainly be sufficient to effect this desirable end; but the whole of the upper deck battery would be at the mercy of a few high-explosive shells which would burst within it, either from contact with a 12-pounder mounting or any other cause, and the whole of the main deck space from stem to stern, except the eight closed casemates, including the entire series of officers' cabins, would be mere shambles in a quarter of an hour. If any one doubts the probability of this, let him go over the *Resistance* and judge for himself. She is an object-lesson the value of which cannot be controverted.

But, it may be asked, is there any remedy for such a condition of terrible insecurity as regards the officers and crews of our war-vessels in the future should the high-explosive shell do all that is expected of it? We believe that there is a partial remedy, but we fear not one that will commend itself in the eyes of our naval constructors. Looking at the *Powerful* or *Diadem*, the enormous freeboard given to these types cannot but excite observation. Is it excessive or not? That is the question. We cannot help thinking that, in running away from the evils of low freeboard, we have now run into the opposite extreme, if only the casemates can be adequately protected with armor against high-explosive shells, whilst vessels of so high a degree of freeboard are being built. We would cut them down in future and utilize the saving in weight of material thus released to provide a more extensive system of armor protection over the reduced surface of the ship's sides. As the *Powerful* and *Diadem* types are at present, they are merely huge targets, which will be the sport and pastime of an energetic enemy who may possess guns firing high-explosive shells; their only chance in action would be to at once crush their enemy with their own high explosives, or run away and trust to the diminishing perspective of their form as they disappear over the horizon for the chance of not being hit. As regards our battleships, it is difficult to suggest anything; but surely a milieu could be designed between the *Nile* and the *Trafalgar*, which possess almost perfect immunity from the chance of destruction between decks by high-explosive shells, and the *Majestic*, which has none whatever about the main deck. Here is food for reflection.—*Journal of the Royal United Service Institution.*

AMERICAN AND EUROPEAN ARMOR PLATE.

The following important paper on the relative qualities and efficiency of European and American armor plate for warships has recently been submitted to the United States Senate Committee on Naval Affairs, by Captain O'Neill, Chief of the Bureau of Ordnance of the Navy Department:

While the great German concern has manufactured armor for many years, that made by the so-called Krupp process, which has of late attracted attention, dates from the test of an 11.8 in. plate, at Meppen, on September 15, 1895. In order to arrive at any satisfactory conclusions as to the superiority of Krupp armor over that manufactured up to the present time in the United States, or as to their relative merits, it is necessary to make a comparison of the tests applied and the results attained in both cases.

First, it should be observed that the much-advertised Krupp plates and English plates supposed to have been treated by the Krupp process are purely experimental or special plates, and do not, as far as can be ascertained, represent service armor, though they may result in setting a standard for future manufacture. From published statements, the Krupp plate referred to showed unusually good ballistic qualities, having successfully withstood the impact of three 12-in. armor-piercing projectiles, having striking velocities of about 1,993 foot-seconds. This plate, according to the formula used for computing velocities necessary for the perforation of face-hardened plates, should have been perforated by a 712.6 lb. (12-in.) projectile, having a striking velocity of 1,829 foot-seconds, whereas it successfully resisted projectiles having 164 foot-seconds greater velocity. None of the three shots perforated the plate, but from the fact that the back bulge, due to the third impact, was 3 in. high and slightly cracked, it would appear that the limits of its resistance had been almost reached; its most notable feature was the absence of cracks. It is worthy of note that in the test referred to the projectiles used were of Krupp's own manufacture, and, while no doubt of good quality, it is impossible to make a direct comparison with projectiles or plates made in this country. A slight degree of inferiority on the part of the projectile enables a plate to make a remarkably good showing, and the fact that the plate was tested at Krupp's proving ground with his own projectiles is not as convincing as it might have been under other conditions; nevertheless the test and its results seem to have been accepted, and the plate is referred to as the champion thick experimental plate.

In the *London Times* of August 20, 1897, is a report on an 11½ in. plate made by Vickers, Sons and Co. (English), which was officially tested at Shoeburyness on August 19, 1897. It was attacked by three 12-in. Holtzer projectiles, weighing 714 lb., with 1,861, 1,868 and 1,860 foot-seconds velocity, which only penetrated 2¾ in. The plate successfully withstood the attack without cracking, and made a record about equal to the Krupp plate. By calculation it should have been perforated by a velocity of 1,814 foot-seconds, whereas it was not perforated with a velocity of 51 foot-seconds greater. The plate was called a nickel Harveyed plate; but as Messrs. Vickers have adopted the Krupp process, and dwelt on its excellence for thick plates, it is extremely unlikely that for this important test a Harvey process plate was submitted. The *English Engineer*, referring to this test, says: "We would again finally express the wish that we could try the powers of other projectiles besides those of Holtzer; he himself has protested against his 6-in. shot delivered in 1889 being taken as a sample of what he could now supply, excellent as they were for their day. Cannot Elswick—Sir W. G. Armstrong, Mitchell and Co. supply us with some of its Wheeler-Sterling (American) shot? It is only fair to our own plates to forestall the objection, which will naturally be made abroad, to calculations based

on our trials made with Holtzer shot only." Here we have two tests of what are considered superior thick plates treated by the Krupp process, but with some doubt as to the quality of the projectiles used.

On May 29, 1897, the Carnegie Steel Company, U. S. A., presented for test at Indian Head a 12-in. experimental plate of re-forged nickel-steel face-hardened armor, which was attacked with one Holtzer and one Wheeler-Sterling 12-in. projectile. There were no cracks. The first impact was with a Holtzer armor-piercing projectile weighing 850 lbs., with striking velocity of 1,811 foot-seconds; the point of the projectile just perforated the back bulge. The projectile, which seemed to be a good one, broke up; some few fragments got through, but the bulk of it fell in front of the plate. The Wheeler-Sterling projectile of 850 lb. weight was fired with a striking velocity of 1,769 foot-seconds; it smashed on the plate, a portion of the head remaining in the impact. By the formula this plate should be perforated by a 12-in. projectile of 850 lb., with a velocity of 1,696 foot-seconds, whereas it was just defeated by a velocity of 1,811 foot-seconds—i. e., 115 foot-seconds more than that required for perforation. The Carnegie plate, to have been equal to the Krupp plate, should have defeated an 850-lb. projectile at 1,846 foot-seconds; it fell short of it by 35 foot-seconds. The angle of impact in the case of the Krupp plate was 9 deg. from the normal, while in the case of the Carnegie plate the impacts were exactly normal. The former plate was slightly cracked after three impacts, while the latter showed no signs of cracking after two rounds. All in all, it may be fairly said that this Carnegie plate is fully as good as that of Krupp. In comparing the tests, the velocities used must not alone be considered, but the striking energy due to weight and velocity, as the projectiles used against the Carnegie plate weighed 850 lb., as against 712.6 lb. of Krupp and 714 of Vickers.

None of these three were service plates. The two former are quoted to illustrate the development reached abroad with thick plates treated by the Krupp process, and the latter that reached in this country by other means than the Krupp process, showing that the difference is slight.

There is no question but that Krupp armor has been, and is, equal to, if not superior to the armor of England, France, Russia, and Austria, but it is equally certain that armor made in this country has been fully equal to any service armor made abroad.

It is reported that on account of the good showing made by Krupp with his 11.8-in. plate, he received a contract for armor for the Russian battleship *Poltava*, a vessel of 10,950 tons displacement, carrying a 15.7-in. belt and turrets of 10-in. thickness; but the nature of the ballistic requirements for this armor are not given. From the fact, however, that the Russian armor made in this country was not required to withstand as severe a test as that made for United States vessels, it is reasonable to suppose that the test required for the *Poltava* armor was not unduly severe. The price paid for this armor was £104 15s. and £108 11s. per ton, delivered in St. Petersburg.

The advent of the Krupp plate evidently created some stir among the British armor makers, for it was soon reported that they had adopted his process, and in March, 1897, the English firm of Vickers, Sons and Co. presented for test a 6-in. plate, which was officially tested, under the direction of the British Admiralty. It successfully resisted, without perforation or serious cracking, the attack of five 6-in. Holtzer projectiles

of 100 lb. weight, having a striking velocity of 1,960 foot-seconds. The plate was reported as of Harveyed nickel steel, containing 4 per cent. of nickel, but is believed to have been treated by the Krupp process, as Vickers is known to have acquired it. The test applied to a 6-in. plate in the United States is less severe than that given to this experimental plate, and heretofore has consisted of one low velocity or cracking shot at 1,472 foot-seconds, and one high velocity shot for penetration at 1,959 foot-seconds. The calculated velocity—verified by practice—for the perforation of 6-in. plates by a 6-in. projectile is 2,084 foot-seconds, and it is proper to say that while our acceptance test is lower than that applied to the Vickers plate. Six-inch plates of American manufacture, have shown on subsequent attacks that they were capable of standing much higher velocities of impact than those required or than those applied to the Vickers plate. Six-inch plates of American manufacture, not special plates, but for ordinary service or for test of projectile, have successfully resisted numerous impacts with velocities of 1,986 foot-seconds, and in January, 1897, a Carnegie 6-in. plate furnished to test projectiles received impacts from 35 6-in. projectiles, the majority of them at velocities greater than those required to insure perforation of ordinary service plate. It must again be noted that the Vickers plate was attacked by Holtzer projectiles, which renders it impossible to make an exact comparison with American plates tested with American projectiles. The most recent Admiralty requirements are that a plate 8 ft. square by 6 in. thick shall resist five Holtzer steel projectiles of 100 lb. weight at 1,920 foot-seconds striking velocity without serious cracking, but we cannot learn as yet that any contracts have been made under these requirements.

Brown and Co. on July 20, 1897, submitted two 6-in. plates, which were officially tested by the British Admiralty under the same conditions as the Vickers plate, and both successfully fulfilled the requirements. In July, 1896, a 7-in. re-forged plate, representing the 8-in. turrets of the U. S. S. Iowa, made by Carnegie, after passing the regular ballistic test for acceptance, consisting of two impacts of a 6-in. projectile at striking velocities of 1,620 and 1,816 foot-seconds, giving a penetration of 2 in. and 3 in. respectively, was further tested with ten 6-in. projectiles of 2,100 foot-seconds, giving penetration of from 2 in. to 3.75 in.

In September, 1896, the British Admiralty tested a 6-in. plate made by Cammell, under circumstances similar to the test of the Vickers plate; it was reported as of Harveyed nickel steel, and made an excellent showing, but not quite equal to that presented by Vickers. Very likely this plate was treated by the Krupp process.

Beardmore, in Scotland, is reported to have taken a contract for armor for a Danish monitor, under ballistic requirements as high or higher than the Vickers plate quoted, and is said to have thrown up the contract.

No conclusive results or wholly satisfactory information concerning the value of the so-called Krupp process can be arrived at except by means of tests made by ourselves.

The American armor makers have acquired the rights to use it, because they wish to bid on foreign contracts, and to do so must be on an equality with foreign manufacturers. They are not prepared to make armor by the Krupp process, and cannot even state approximately when they will be able to submit a trial plate—though they expect ultimately to do so—and cannot guarantee that their first effort will be successful. They say they would not be willing at the present time nor the near future

to take a contract under materially more exacting ballistic requirements than the last contracts for armor made by the Krupp or any other process, nor can they name a price for such armor.

As an item of interesting information, the last bids for Russian armor, the contract for which has not yet been awarded, are given, as follows; times for delivery, fourteen to eighteen months:

Vickers, Sons and Co., £116 16s. per ton; John Brown and Co., £113 18s. per ton; St. Chamond, £98 to £109 12s.; Le Creusot, £99 12s. to £113 12s.; Chatillon, £97 5s. to £112 12s.; Marrel Frères, £106 to £76 8s.; Krupp, £112 9s.; Dillingen, £111 17s.; Bethlehem, £106 2s.; Carnegie, £106 2s.; Wilkowitz (Austria), £90 9s.

My convictions are that armor manufactured in this country is fully equal to the best service armor yet manufactured abroad; that the tests as heretofore applied have been such as to secure a high standard, and that they are as severe as those heretofore applied abroad and represent more fully the actual quality of the armor supplied, more so than does the method of testing in vogue in England; that the armor presented in this country would have withstood tests considerably more severe than those to which it was subjected, and that the tests are and have been reasonable to the contractors, and so drawn as to carefully protect the interests of the Government. In the specifications recently prepared, which it is prepared to use in case of future contracts, a new table of velocities has been inserted, making the tests more severe than heretofore.

In testing armor in this country the plates of a group are carried on together until all are carbonized; there is usually one more plate than the number required; the inspector at this stage selects the plate which in his opinion is the poorest of the group for the ballistic test. It is understood that in England a small plate or plates of the size and thickness submitted by the armor manufacturer for the standard of his manufacture, is carried along with the group, and such plate or plates are used for the ballistic test instead of one of the plates of the group, so that their test is not as representative a one as is ours. It is the custom for the armor makers of Great Britain to submit from time to time experimental armor plates for test. Such plates are tested by the Admiralty, and those making the best records are adopted as the standards which must be reached by the manufacturer to whom a contract is awarded. This naturally leads to considerable rivalry among the armor manufacturers, and the extensive ship-building programmes always being carried on in England, and the natural desire for prestige, warrant the expenditure of time and money to develop new and improved quality of armor, and while the manufacturers may combine to regulate the cost of armor for ships of the Royal Navy, as England builds ships of war for several foreign governments, the makers of what may be termed "champion plates" naturally stand the best chance for orders, both domestic and foreign; hence the incentive to excel is very great. It will be observed that there is no fixed ballistic standard except such as is made by the test of champion plates.

In this country the conditions are somewhat different, the Navy Department having heretofore established the ballistic requirements for all armor manufactured, the last ones being based upon the de Marre formula for determining the velocities necessary to insure perforation of high carbon steel plates and backing, plus fifteen per cent. for face-hardened armor. The specifications for armor for the Kearsarge and Ken-

tucky are based upon the foregoing, and the actual velocities used against the ballistic plates, representing groups of armor, are, in the case of thick plates, about $14\frac{1}{2}$ per cent. lower than that required for perforation for the high velocity shot, and about 35 per cent. less for the low velocity shot; for thin plates the high velocity shot is about 20 per cent. less than that required for perforation, and about 30 per cent. less for the low velocity shot.

These requirements seeming somewhat irregular, the new proposition is to fire two high velocity shots, both of which have a velocity of 17 per cent. less than that required for perforation. After the first shot there shall be no through crack in the plate, nor shall the projectile or any fragment thereof pass entirely through the plate and backing, and no part of the shell is to pass, on the second shot, entirely through the plate and backing. It is believed that these requirements insure armor of as good resisting quality as is in use in any country. It is impossible for any one to say that the maximum degree of excellence has been reached in the manufacture of armor; and in this country, where the demand is so limited, the best way to encourage the development and improvement of armor would be to make the ballistic requirements as high as is prudent and reasonable, and when making contracts to offer a premium of a fixed sum on such ballistic groups as may excel, by some specified amount, the contract requirements. This is the method adopted in France; a premium of 5 per cent. on armor at £80 would be but £4 per ton, or £10,000 on 2,500 tons of armor at that price, supposing it all earned the premium. It is not unlikely that the American armor makers would be willing to accept higher ballistic requirements if they were permitted to carry along with each group special plates of 6-in. thickness to be used for the ballistic test, as it is reported is done in England, but such a measure would not be calculated to secure service armor of the best quality. At present the Bureau of Ordnance sees no good reason for increasing the ballistic requirements beyond the point proposed and heretofore stated, but does favor the payment of premiums for greater excellence. While the English firms of John Brown and Co., Cammell and Co., and Vickers, Sons and Co., the French firm of St. Chamond, and the American firms of the Bethlehem Iron Company and the Carnegie Steel Company have acquired the right to manufacture under the Krupp process, the development of that process and its status in this country at the present time is not such as to warrant its consideration in connection with the armor for the new battleships Nos. 7, 8 and 9. The future alone will reveal its value, so far as its manufacture in the United States is concerned. The proposition outlined as to premiums will probably secure the best armor that can now be made in this country for these vessels.

An experimental plate is now being made in this country, and should be ready for test in a few weeks. It is made by the Chase-Gantt process; it was cast 18 in. thick, in a mould faced with ferrochrome and some other substances. It was then forged down to 10 in. in thickness and tempered, that is, face-hardened. It is not known as yet with what degree of uniformity such plates can be reproduced, or what ballistic showing it will make, nor at what cost such plates can be produced, but probably cheaper than by the Harvey process.

It is reported from abroad that the Krupp process will be more costly than the Harvey process. The Krupp process is not patented, but is a trade secret. It is not improbable that the carbonizing is done by means

of a hydrocarbon gas instead of the former method of cementation. It has been learned that the Russian government did not accept any of the bids herein referred to, and it was understood that they contemplated making the armor themselves; it is also rumored that the contract will again be placed on the market.

In 1887 and 1890 this Government offered premiums for armor possessing qualities superior to contract requirements, but the introduction of nickel steel and face-hardened plates upset calculations for the time being; the problem is now sufficiently well understood to warrant a return to that method. There is a clause in all our contracts which provides that any new or improved methods that may be developed may be required by the Government, but this implies modification in price, and is so stated.—*The Engineer*.

TEST OF A SPECIALLY PREPARED PROJECTILE.

An official trial of a specially prepared projectile was successfully carried out at Messrs. Vickers, Sons and Maxim's range at Swanley, recently, in the presence of representatives of the Admiralty and War Office. The trial was of considerable interest, as it is well known that after a gun has been fired many hundreds of rounds the velocities fall off to some extent, due to erosion and other causes. The point of difference whereby this projectile differed from others was that an arrangement was screwed on to the base of the shell by which a specially prepared ring was made to expand in the eroded portion of the bore so as to overcome the injurious effect of erosion, caused by smokeless powders, as well as to prevent the shot being over-rammed, should the bore be worn by this or other causes. The general principle of the gas check depends upon the compression of this specially constructed ring by an annular copper ring, which conveys pressure to the specially constructed ring in such a manner that the specially constructed ring makes a perfect metallic seal against the bore, and completely prevents any gas at a high temperature and pressure passing the base of the shot, and hence does away with the principal cause of erosion in guns. Four rounds were fired with this specially banded shot, and four with the ordinary service shot, and it was found that the whole of the energy of the gun was restored after upwards of 250 rounds had been previously fired. The actual ballistics obtained were 2,694 feet per second for a pressure of 13 tons with a 25-lb. charge of cordite. By increasing the charge by a moderate amount and slightly increasing the initial chamber pressure, a velocity of 2,900 feet per second could reasonably be expected. It is claimed that this simple application is capable of being applied to almost any design of shell at a very moderate cost, and by its application it is confidently expected that guns after firing many hundred of rounds will be equally efficient, as far as energy is concerned, to a new gun.—*Journal of the Royal United Service Institution*.

THE VICKERS 6-INCH QUICK-FIRING GUN.

It would be difficult to overrate the importance of efficiency in a 6-in. gun at the present moment. In action the heavy guns fire but slowly, their effect may be very great, but the number of rounds got off from

them in a critical period may probably be too small to eliminate the elements of uncertainty. The very light quick-firing pieces are so much exposed that it is a question if they could be fought at all in close action. Consequently the fire that many officers depend on mainly is that of the heavier quick-firing guns, and in the British service these are 6-in. pieces, protected by 6 in. of steel in all our best vessels. Speed and power in our 6-in. quick-firing guns, then, is especially to be desired, and hence the importance of the 6-in. gun brought out recently by Messrs. Vickers, first tried on board the Pincher gunboat at Portsmouth on October 21 last, subsequently at Shoeburyness, and adopted for the service in January last. Its length of bore is 45 calibers, and its weight 7 tons 8 cwt. It is of wire construction, and proportioned to bear the prolonged pressure of its large charge of 25 lb. of cordite during the passage of the shot up the bore. It will be seen that the mounting carries a small curved shield of special nickel-treated steel, which has been proved to possess high resisting power, although the steel is able to be brought to the abrupt curve needed for the shield.

There are three leading features in the gun as put forward and tried: (1) great energy; (2) special breech action, giving ease and speed of working; and (3) obturation sufficiently complete to enable the metal cartridge commonly used in quick-firing guns to be dispensed with. On the day of trial at Portsmouth a muzzle velocity was attained with a 100-lb. projectile of 2,784 foot-seconds, implying a muzzle energy of 5,373 foot-tons, and a perforation of 22.7 in. of iron by Tresidder's formula. This, it need hardly be said, is extraordinary, the greatest perforation laid down in the service table for a 6-in. gun being 15.9 in. of iron. In stating this, we feel it necessary to recognize that it is extremely difficult to maintain such a performance as the gun continues in use. Very rapid fire with very large charges of cordite involves an amount of wear that it is very difficult to resist. Messrs. Vickers, however, have confidence in having arrived at effectual means of prevention.

To come to the second leading feature, that is, ease and speed of working. The screw is made on a system embodying the Weling patent. For the interrupted thread of the French system is substituted in the portions or segments differences in radius exceeding the height of the screw thread, which may consequently be continued throughout, except where a break or interruption is made to take the segment whose thread stands highest. This succession of steps may be repeated. It occurs twice in the 6-in. gun. In the 12-in. gun the succession of steps is repeated three times. In each case there is a considerable gain in the length of screw thread bearing, as compared with the French interrupted system. The screw and mechanism of the 12-in., as may be seen, are very light compared with the large diameter of the bore. The advantage is perhaps still more apparent in the 12-in. than in the 6-in. In this three-quarters of the circumference of the screw are used for effective thread section, only one-quarter of the circumference being non-screwed. On this account the screw can be made lighter and shorter than in other types, and consequently a lighter carrier can be used, and the manipulation is rendered more easy and rapid. Further, the shortness of the screw admits of the gun itself being shortened at the breech, that is at the heaviest part, and great weight is saved which can be utilized elsewhere. Both the 12-in. and 6-in. mechanisms have practically the same system of firing gear. There is an automatic tube-ejector which throws out the primer when the breech is opened. The tube can be placed in the vent either with the breech open or closed, and in the case of a misfire it

is not necessary to open the breech to withdraw the tube. Safety gear exists, rendering it impossible to fire the gun without the breech being closed and locked either on the electrical or the percussion-firing system.

Returning to the 6-in. quick-firing piece, the third leading feature in the gun is obturation dispensing with the use of a metal cartridge. This is facilitated by the shortness of screw, so that it has been found that the De Bange obturator can be rendered efficient. The advantages of this are obvious; the doing away with the metal case saves weight and magazine room, and saving of weight facilitates the rapid and easy working of the gun. There is also probably a saving in expense. No ejection of case being required, mechanism is simplified. Throughout the trials at Portsmouth and Shoeburyness the breech mechanism worked with complete ease, the tube was satisfactorily ejected automatically, and the obturation was complete. The heating of the metal was also watched, and considered to be well under the needed limit of temperature.

The Shoeburyness trial took place on January 13 in the presence of the representatives of the War Office and Admiralty. The object of this further trial was to test the accuracy of the gun after having fired upwards of 200 rounds, including the rounds fired at the proof of the gun; and also to submit the gun to a further test for rapidity, under conditions of service, using a 100-lb. shot, a cordite charge, and service primers. The trial commenced with a series of ten rounds, the result of which showed that the accuracy of the gun had not fallen off in consequence of the great amount of work already done by it. On the contrary, on two occasions the projectiles passed through the same hole in the target.

Suspension of firing then occurred, due to the weather becoming overcast, but in the afternoon it cleared, and the rapidity series was successfully completed. This series was conducted by a crew of seamen gunners specially sent by H. M. S. Excellent for the purpose, and were in charge of Lieutenant-Commander J. Murray Aynesley, the experimental officer of the gunnery school at Portsmouth. Thirty-six rounds were fired in four minutes forty-seven seconds, and this time included taking temperatures of the vent head, which operation was considered desirable, owing to the very rapid rate of fire. This rate of fire gives practically one round per each eight seconds, or at the rate of one hundred rounds in thirteen and one-third minutes, which, for practical considerations, allowing one hundred seconds for cooling during the hundred rounds—this extra time would probably be necessary for the supply of ammunition on board ship—would give a rate of fire of one hundred rounds in fifteen minutes.

For a short series of rounds such as one would expect in an engagement of, say, from ten to twenty rounds fired intermittently, an even greater rate of fire would be obtained. Analyzing the rounds fired during the trial, the maximum rate of fire attained was one round in six and one-half seconds, and eight rounds were fired each taking seven seconds, and another eight rounds each taking seven and one-half seconds. The other rounds varied from eight to nine seconds.—*The Engineer*.

VICKERS' QUICK-FIRE FIELD GUN.

A trial of a quick-fire gun of Messrs. Vickers took place at Messrs. Vickers' range at Eynsford this week, in the presence of officers repre-

senting the War Office and Admiralty. As most of our readers are aware, the difficulties of applying quick fire to field guns are—first, the fact that it is essential that the gun should not require relaying each time it is fired; and secondly, the fact that the metal cases of quick-fire ammunition add greatly to the weight to be carried, and are troublesome. The recoil in guns mounted on decks and behind breastworks is generally partly checked, and the gun probably recovers its original position and laying by the action of springs, etc. In the field this has never hitherto been completely carried out, but there are various more or less successful arrangements. Vickers claim to have achieved this so as to render raising up unnecessary, both with howitzers and high-velocity pieces. The following description is supplied: "The recoil and subsequent return of the gun to the firing position are operated by a specially constructed device fixed under the protection of the trail, which is arranged to allow both the gun and mounting to recoil, thereby making use of the whole available mass for overcoming the energy of recoil, the result being that the jump is eliminated and the gun run out into the firing position without alteration of the slight alignment. One of the special points by which the system is characterized is that it readily admits of its application to existing artillery without any serious modification to the existing type of mounting, and the mounting when altered is, within a few points of percentage, equal in efficiency to an entirely new quick-fire field equipment. The total weight of the gun and mounting complete, including mechanism, wheels, quick-firing attachment, tools, etc., is 19 cwt. The weight of the limber is not here recorded, as this depends on the weight of the ammunition intended to be carried by any particular equipment.

"Twenty-seven rounds were fired in all, with charges of $16\frac{3}{4}$ oz. of ballistite, the weight of the shell being $13\frac{3}{4}$ lb., and a velocity of 1,650 foot-seconds was obtained for a pressure of 14 tons. Two rounds were first fired to exemplify generally the working of the system, after which fifteen rounds were fired for rapidity, each round being carefully laid on the target. These fifteen rounds were fired in 67 seconds, which gives a rate of fire of $13\frac{3}{4}$ rounds per minute. A second series was then fired, during which the gun was very carefully laid and was placed pointing deliberately forty degrees off the target, and the time was taken from the gun's crew working the gun from this position into the alignment, and proceeding with the firing in such a manner as would take place when a gun was being taken into action on service, the time being taken for unlimbering. Under these circumstances ten rounds were fired in 125 seconds, or at the rate of five rounds per minute, each of the rounds being carefully laid on the bull's-eye. Six rounds were then fired from a mountain equipment at the 1,000-yards range, when excessively good shooting was obtained, but the shooting under these circumstances is not now specially reported, as the equipment was one of which the results are well known, and which is being successfully used in Egypt, this type of gun having made excellent shooting recently at the battle of the Atbara.

"It is of interest to note that the Egyptian Government are now in possession of six complete batteries of these guns, which use shells of $12\frac{1}{2}$ lb., and 20 lb. double shell when desired.

"At present metal cartridges are used, but it is claimed that they can be dispensed with, as in the 6-in. quick-firing gun, the De Bange pad being used."—*The Engineer*.

A NEW METHOD OF MAKING HARD-FACED ARMOR.

Taking advantage of the fact that by suitably controlling the process of cooling, it is possible to obtain some of the newer alloys of iron with nickel, cobalt and manganese in either a hard or a malleable condition, M. Jean Werth, manager of the Société Anonyme des Hauts Fourneaux et Aciéries de Denain et Anzin, has devised a new process of making armor plate. M. Werth's contention is that the plate should have the same chemical composition throughout, and that the hard face should be obtained entirely by a process of tempering. Ordinary carbon steel in large masses cannot be tempered satisfactorily, but when alloyed with suitable proportions of nickel, cobalt or manganese it is possible to obtain the metal in a hard state by heating it up to a bright red and allowing it to cool in the air; whereas, if heated only to a dull red and cooled, the metal will be malleable and comparatively soft. The steel used by M. Werth is open-hearth metal, free from sulphur and phosphorus. It contains from 5 per cent. to 15 per cent. of nickel or cobalt, and from 2 to 12 per cent. of manganese, whilst within certain limits silicon, chromium or tungsten may be present without interfering with the process of tempering. In its soft state such a steel has a tensile strength of 110,000 lb. to 140,000 lb. per square inch, and a strip $1\frac{1}{4}$ in. thick can be bent without cracking round a radius equal to its thickness. After the plate is completed, it is tempered by making it part of the side or bottom of the furnace. The face next the fire thus becomes heated to a bright red, whilst by means of water or air the temperature of the back face is kept down to 800 deg. or 900 deg. Fahr. To insure good results the heating is effected very gradually, the plate being put into a cold furnace; and by preference gas fuel is employed in the latter. Another method of effecting the heating, which is, however, only applicable to flat plates, is to immerse their front faces in a bath of red-hot lead, the temperature of which is maintained very uniform. When ready, the plate is removed from the furnace and cooled at the back, until the front face has sunk down to a temperature of 800 deg. to 900 deg. Fahr., when no further attention is required, though if warped it can now be straightened before the cooling is finished.—*Engineering.*

THE UNITED STATES NAVY—GOOD AND BAD POINTS.

The present war will certainly throw much light on various problems of naval architecture which are now but vaguely understood, and it may solve them completely and satisfactorily. Already the superior points of the navy have been demonstrated and its weaknesses made manifest. The most important and prominent fact has been the reliability of the ships, considered as a unit, and the capability of the several types for the work they were designed for. A continuous and hard duty for several weeks, cruising under high pressure, and repeatedly employing all the guns, has failed to show a single defect of a serious nature in either hull, machinery or armament. The protective qualities of the boats have not been tested in the slightest degree.

Too much praise cannot be extended to the designers and builders of the propelling machinery. The uncertainty which has been felt as to whether this portion of a naval vessel would stand long-continued service has been removed. That this doubt existed was shown by the statement of the late Admiral Meade, at a meeting of the Naval Architects and Marine Engineers, two or three years since, that he would like to have one of the fast cruisers attempt to follow one of the Atlantic liners in a trip to Europe, the object being to practically test the staying qualities of the cruiser. The seagoing ability of the battleships has been proved by the wonderful voyage of the Oregon, which joined the fleet off Cuba in every respect able to do her full share of the work.

The monitors were intended for coast defense. Their limited coal capacity and consequent exceedingly small radius of action make it impossible for them to be independently useful at any considerable distance from a base of supplies. This was illustrated during the movement of the fleet toward Cuba, when coaling at sea was necessary, and when the speed of the fleet had to be regulated by that of the monitors. Those characteristics also prevent the monitor class assuming a position in a naval engagement—it must be content to fight in the position its quicker enemy chooses to place it. Its seagoing ability has also been criticised. For coast defense the monitor, with its tremendous power, ample protection and small target presented, will undoubtedly prove to be of the greatest use. An unknown factor is found in the ram Katahdin. Whether this vessel will occupy a niche peculiar to itself remains to be seen.

The big guns and their turrets have worked without a hitch. At the present time the life of these guns, or the number of times they can be fired with full service charges, is not known with any degree of certainty. It is possible that the experience now being gained may lead to experiments with guns of greater caliber length than any now employed. Experiments have been made abroad with lengths as great as 50 and 60 times the bore, but the results are more or less uncertain. The American built-up gun would appear to lend itself to this extension, and if such should prove to be the case the advantages gained would be of the utmost value. The good resulting from the use of smokeless powder has been shown by the New Orleans. According to the dispatches, the rapid dissipation of the light smoke from her guns permitted their being handled more rapidly than those using ordinary powder.

In addition to a general weakness in numbers in all the types, the American Navy is particularly feeble in torpedo boats and torpedo-boat destroyers, and in high-speed, partially-protected scouts or dispatch boats.

With so many experts watching for points of excellence or features of weakness, we may expect a thorough account at the close of the war. With the public thoroughly aroused to the necessity of possessing the best vessels, equipped in the most modern way, there can be little doubt that Congress will promptly vote the necessary appropriations.—*Iron Age.*

RIGHTS AND DUTIES OF BELLIGERENTS AND NEUTRALS.

At the Royal United Service Institution, on May 19, Mr. J. Macdonell, LL. D., Master of the Supreme Court, delivered a lecture on

"Recent Changes in the Rights and Duties of Belligerents and Neutrals according to International Law." Sir Robert Giffen, K. C. B., presided.

Mr. Macdonell said that when he arranged with the secretary, about six weeks ago, respecting his lecture, he did not anticipate that the subject would have the living interest which it now possessed. He proceeded to point out how international law was in a state of rapid transition, and that much that was taught in books on the subject had become obsolete. Among the great changes affecting international law were the decline in the belief in the "law of nature" and in the influence of Roman law; the doctrine of the equality of States was also no longer accepted as it once was; international law was now based on a community of civilization, and another great change was the growth of "military realism"—a spirit which found eloquent expression in much of the military literature of Germany. In dealing with the chief recent changes which have taken place in international law, he took as the starting-point the close of the Crimean war. In 1856 the great powers issued the Declaration of Paris, of which the history was still shrouded in some mystery. Neither Lord Clarendon nor Lord Cowley, the diplomatists more directly concerned, gave a full account of the negotiations; the only detached statement was one published by M. Drouyn de Lhuys, who was French foreign minister at the time. According to that statement—it was borne out by the remarks which fell from Lord Clarendon—that declaration would have been made by the bulk of civilized States whether we had acceded to it or not. Referring to the abolition of privateering, he remarked that perhaps the growing sense of humanity and the recollection of the squalid abuses connected with privateering had something to do with its disuse. But much was due to this fact—the transformation of a merchant vessel into an efficient cruiser was not so easy as it was in the days of Paul Jones or Jean Bart. When that transformation was practicable there was little in the Declaration of Paris to prevent it. Article 2 provided that "the neutral flag covers enemies' goods, with the exception of contraband of war." This closed a long controversy, in which England had, on the whole, consistently maintained her right to seize an enemy's goods wherever found. It was not clear that we could have prevented a general affirmation by the civilized world of the principle, "free ships make free goods." It was not clear that we could have maintained our ancient principle without provoking the hostility of neutral nations, and it was still less clear that we could now rescind what we did in 1856. One could not lose sight of the fact that exemption from capture on sea was probably for a long time to come out of the question. Such exemption would be in war to the supreme advantage of England, which stood to lose so much. The Declaration of Paris did not deal with contraband of war, and he could not say that as to this in recent years, either here or elsewhere, there had been any distinct change. No prize courts had for many years sat in this country. When they went to war they would see them applying doctrines and principles of a startling character, and highly unfavorable to neutrals—doctrines and principles formed at a time when belligerents were a law unto themselves. Members of Parliament had lately asked the Government again and again whether they intended to prohibit the exportation of contraband. The Crown had power under the customs act, 1879, to prohibit the exportation of certain kinds of contraband—a power, however, which was rarely exercised. A vessel might be contraband, and the fitting of it out might also be an

infringement of the foreign enlistment act, but, speaking generally, there was no power to prohibit the exportation of contraband; the risk of capture was the only penalty. The foreign enlistment act of 1870 made our neutrality law more rigorous than that of any other country. It was the outcome of the complaints of the United States Government as to the defects of our neutrality law in allowing the escape of the Alabama. The English act of 1819 was based on the American statute of 1818, but was in several respects more stringent, and, as he had said, the statute of 1870 still further increased the stringency of English law. But no change of any kind was made in the United States statute. The consequence was that many things punishable here were not so according to American law, and they were not punishable under most other systems. As they were all aware, too, our Government undertook by the Treaty of Washington of 1871 to observe in the future three rules then formulated and to bring them to the notice of other countries. No other nation had adopted these rules, which many jurists treated as unreasonably onerous to neutrals. He was inclined to think that the act of 1870 and the rules of 1871, properly understood, did not go beyond what was reasonable; but it was more heroic than prudent to admit the existence of these duties without insisting on or asking for reciprocity or giving some explanation of the sense in which we understood them. The only occasion on which these rules were construed—at the Geneva arbitration—they received an interpretation which every English lawyer repudiated. In recent wars in which maritime operations have been carried on on a large scale, the chief controversies had turned on the duties of neutrals to belligerents. The events of the last few weeks suggested several desirable modifications in the interest of neutrals. A neutral must be prepared to put up with many inconveniences from operations conducive to the termination of war, but it was plain that the present laws of war permitted of acts which might profoundly injure the neutral without, perhaps, greatly aiding the belligerents or conducing to the close of hostilities. Recalling the effect on the price of wheat here and elsewhere, the far-spreading consequences of the rise caused by vague alarms of capture, let them conceive what would follow from a blockade, maintained even for a few weeks, of the chief American ports. Suppose that in a war between Germany and Russia the ports of the latter were sealed, and that no wheat from Russia was procurable at a time when harvests in America and other countries usually supplying us with wheat were bad, should all neutrals consent to starve in order that the ring might be kept for the combatants and the game of war be played out in the good old way? For the common benefit of civilization, the maintenance and use of certain machinery, plant and services were necessary. The treatment of submarine cables in time of war was a still more difficult and important question, and one as to which international law had so far failed to give any clear guidance. No one could say with confidence what would be its development as to this point. An international convention was entered into at Paris on March 14, 1884, for the protection of telegraphic communication by means of submarine cables; but Article 15 expressly stated that the convention was not to interfere with belligerent rights. Probably effectual safety against the danger here referred to was to be found in the multiplication of lines of communication; but pending extensive developments of telegraphic enterprise it was hard to contemplate calmly the possibility of England's being cut off from India or some

of her colonies, not by her enemies, but by a State professing to be friendly to her, in order to injure some other State. It seemed to him that in any satisfactory convention there should be an article binding the signatories not to cut or injure cables connecting countries with their colonies or dependencies. That the strict enforcement of belligerents' rights as laid down in the text-books would be here ruinous to neutrals, that the new maritime law, slowly disengaging itself from precedents and traditions, must here, as elsewhere, take greater notice of the interests of neutrals—that was the reflection with which he ended.—*United Service Gazette*.

BELLIGERENTS AND NEUTRALS.

The second and concluding lecture by Mr. J. Macdonell, C. B., LL. D., Master of the Supreme Court, on "Recent Changes in the Rights and Duties of Belligerents and Neutrals according to International Law," was delivered on the 2nd inst. at the Royal United Service Institution. Major-General J. F. Maurice, C. B., presided.

Dealing with the recent practice of beginning hostilities before a formal declaration of war, which, it will be remembered, caused difficulty in the American-Spanish war owing to the capture of Spanish and French prizes, Dr. Macdonell pointed out that this was no new source of trouble. Although the ancients always first declared war, the Romans making the occasion one of pomp and ceremony, there was no expressed condition, and a change was introduced in the last century. Great Britain, for instance, refused to give up prizes to France, although taken before the declaration. Such declaration was no longer regarded as obligatory, and even the withdrawal of diplomatic agents might not precede the outbreak of hostilities. Such change and difference of opinion might involve great difficulties, say, with shipowners or shipbuilders, whose obligations as subjects of neutral States could not clearly be recognized. Thus, the lecturer pointed out, a shipbuilder on the Clyde might hand over munitions of war to a belligerent after hostilities had been commenced in a corner of Africa, of the existence of which place the shipbuilder had never heard. Jurists were divided still as to when some of the great wars of this century actually commenced, and thus it was a matter of great importance that some agreement should be come to. On the subject of the severing of submarine cables, Dr. Macdonell had much to say, but he was clearly of opinion that a belligerent had the right to cut a cable even if it terminated on neutral soil, and he instanced the case of Britain being at war, and using the cable which touches at Lisbon for communicating instructions to colonial ports. Obviously the enemy would cut such an important line, which led to the suggestion that it was most undesirable for us to have important telegraphic connections through such small States, which were very liable to be coerced by a powerful enemy. Our trust should not be laid in any chapter of accidents to see us through such a difficulty. The lecturer alluded to the greater humanity of the soldier and of the recognized practice of saving national and private treasures, but he disagreed with most jurists in the view that the outbreak of war made void the debts of the citizens of one State to those of the other belligerent. He urged soldiers and the jurists to combine in the preparation of a first-class comprehensive manual for international guidance.—*United Service Gazette*.

TRIAL OF NEW TORPEDO NETS.

The new torpedo nets tried on H. M. S. Hannibal, have been definitely adopted for service, and the Hannibal, when commissioned, will be equipped with them. They weigh about 30 cwt. per net, half as much again as the old style, but are said to be "quite as easy to handle." I have not seen them in operation, but "quite as easy to handle" is a vague term. Ships have been known to take nearly twenty-four hours getting out their nets, while others have done it in two hours. In part, of course, this has had to do with the crew, but structural peculiarities and often individual peculiarities of individual ships have had as much or more effect. In any case, however, the Admiralty are to be congratulated on their diligence and pertinacity in seeking to solve the problem that—as mentioned last week—both France and Germany have abandoned as hopeless. It is very nearly a cardinal axiom with modern naval officers, that if a torpedo boat finds a ship she will "get home" without much trouble. Of course, the ship's safety lies in the immense difficulty of a boat finding her in war time. I have been in a "boat" and passed within torpedo range of a ship at anchor without a soul on board knowing it; the lost chance was only discovered when the ship opened fire some while after she had been passed by the way. On the other hand, I have known a torpedo miss at a range of 30 yards, or thereabouts, that is, one-tenth of what is considered almost certain range. A ship is a very small target when a boat is steaming fast. In theory, a torpedo will travel 1,000 yards, in experimental practice it will find the target nine times out of ten at 400 yards; in manoeuvres the chances are even that it will hit at 300 yards—in war time they will be certainly half that again. But on the other hand, the ship's chances of hitting the boat are still less, nor is it proved that one hit, or even several, will stop a boat. From the time the boat is sighted until the torpedo is fired is—despite the manoeuvre claims of two minutes under fire—seldom over one minute, and to hit a boat enough to stop her way in sixty seconds will need some very good shooting.

In connection with torpedo boat attack and defense, it is pretty generally known now that the orders for war time are—fire at every boat. Whether it be friend or foe must be discovered later. It is a regrettable thing that in our annual manoeuvres we never properly test this question of what is to happen to the friendly boat, by allotting torpedo boats to each side. In connection with this, it is currently reported in the service that a well-known torpedo officer recently informed the Admiralty that he had a device whereby a friendly boat could make its presence known on board a battleship without visible signal of any sort. The Admiralty, however, refused to allow the money necessary to carry out the experiments, so it remains a secret; presumably it was some adoption of wireless telegraphy. The French are said to be in possession of some such device.

TRIALS OF DUTCH CRUISERS.

In our issue of February 21, 1896, we gave some particulars of the water-tube boilers which were to be placed in three second-class cruisers that were then being built for the Royal Navy of the Netherlands.

RESULTS OF TRIALS OF DUTCH CRUISERS.

Date.	Speed.	Revolutions.	Indicated Horse-Power.	Air Pressure in Water Height.	Number of Boilers.	Coal Consumption per Indicated Horse-Power.	Time.	REMARKS.
	knots					lb. per hour.	hours	
Friesland.								
Oct. 18, 1897..	10.423	71.6	1,077	3 W.-T.	4	No auxiliary engines included in the coal consumption.
Oct. 19, 1897..	12.528	87.25	2,006	....	4 W.-T.	1.84	6
Oct. 20, 1897..	17.275	124.2	5,982	0.4 in.	All 10	1.62	4	
Nov. 3, 1897..	19.87	147.27	10,416	{ 0.8 in. to	All 10	1.67	4	
Nov. 3, 1897..	Maximum	148.3	10,850	{ 1.16 in.	All 10	....	4
Zeeland.								
Dec. 28, 1897..	10.24	64.2	1,162	3 W.-T.	4	Propellers at 17½ ft. All auxiliary engines included in the coal consumption. Propellers at 16 ft.
Dec. 29, 1897..	12.4	78.6	2,062	....	4 W.-T.	....	6
April 5, 1898..	19.47	138.58	9,818	1.2 in. to 2 in.	All 10	2.06	4	
April 5, 1898..	Maximum	141.5	10,589	1.2 in. to 2 in.	All 10	....	4
April 6, 1898..	16.466	114.22	5,203	0.4 in.	All 10	2.1	4	
No feed-heater was fitted in this case.								
Holland.								
Feb. 6, 1898..	9.973	70.04	1,216	3 W.-T.	4	All auxiliary engines included in the coal consumption. Ship had been docked lastly Feb. 4.
Feb. 9, 1898..	11.63	80.51	1,778	....	4 W.-T.	....	6
Feb. 24, 1898..	16.92	123.0	6,236	0.4 in.	All 10	....	4
May 10, 1898..	19.618	145.86	10,541	0.8 in. to 2 in.	All 10	2.28	4	
May 10, 1898..	Maximum	149.9	11,712	....	All 10	....	4

GENERAL REMARKS.—The indicated horse-power is the indicated horse-power of the chief engines only. The stokers on board the Zeeland and Holland had not been so well trained as on board the Friesland.

These vessels were the *Holland*, *Friesland* and *Zeeland*. It will be remembered that Mr. Andrae, the engineer-in-chief to the Dutch Navy, determined to try the result of a combination of small tube or express water-tube boilers and return-tube boilers in these vessels, and selected the Yarrow boiler as most suitable for the purpose. As a consequence, Messrs. Yarrow & Co. were commissioned to construct, at their works at Poplar, one Yarrow boiler for each ship, making three in all, and these were intended to act as examples for the remaining water-tube boilers required that were to be made in Holland. We have been furnished with the particulars of the trials of these vessels, but before repeating them it will be convenient if we give some details of the vessels themselves.

The *Friesland* has been built and engined by the *Maatschappij voor Scheeps en Werktuigbouw Fijenoord* at Rotterdam, an establishment of which Mr. Croll is the director; and the *Zeeland* by the *Koninklijke Maatschappij de Schelde* at Flushing, of which Mr. van Raalte is the director; whilst the *Holland* was built in the Royal Dockyard at Amsterdam, and engined by the *Nederlandsche Fabriek van Werktuigen en Spoorweg Materieel* at Amsterdam, of which Mr. Strumphler is the director. These vessels are 306 ft. long by 48 ft. 6 in. wide and 17 ft. 9 in. deep. The displacement is calculated at 3,900 tons with 400 tons of coal on board, the total coal supply being 850 tons. The vessels are twin-screw, and have triple-expansion engines with cylinders 33 in., 49 in. and 74 in. in diameter by 39-in. stroke. The propellers are 14 ft. by 16 ft., and have 60 square feet of surface. It may be noted that the propellers of the *Holland* turn outwards, and those of the other two ships inwards. The boilers, which are the most interesting part of the machinery, consist, in each ship, of two of the return-tube type, having a grate surface of 126 ft. and a heating surface of 4,005 ft. The eight water-tube boilers have 322 square feet of grate and a heating surface of 16,136 ft. As stated, Messrs. Yarrow made one boiler for each vessel, the remainder being constructed by the Dutch firms. The total maximum horse-power for which the boilers of each ship were designed to supply steam was 9,250 indicated. Of this, 2,250 horse-power was to be obtained from the two return-tube boilers, and the remaining 7,000 horse-power from the eight Yarrow boilers. The weight of the return-tube boilers with water was 120 tons, and that of the eight water-tube boilers with water 88 tons. The total weight of propelling engines and boilers and water, together with pumps, fans, funnels, floor-plates, ladders, and all other things which can be included under the category of propelling machinery, was for the *Holland* 635 tons, for the *Friesland* 611 tons, and for the *Zeeland* 570 tons. The *Holland* and *Friesland* have Weir's feed-pumps and feed-heaters. The *Zeeland* is fitted with Yarrow's automatic feed-control arrangement, and has a Worthington pump to each boiler, but has no feed-heater. There are steam steering engines, dynamos for electric light and for search-lights, air compressors for torpedoes, steam capstans, refrigeration engines, Sturtevant blowers for ventilating purposes and to supply hot or cold air, evaporators, feed-water filters, and other auxiliary machinery and fittings.

The results of the trials are given in the annexed table. The steam pressure in both return-tube and water-tube boilers was 200 lb. to the square inch.

The object of the Dutch naval authorities in adopting the combined arrangement of boilers was to gradually accustom the stokers to the new type. In three similar cruisers being built in Holland, and which

are to be launched shortly, Yarrow boilers only are being fitted; there being twelve in each vessel.

It may be interesting to compare the results obtained on the trials of these vessels with those of the *Diadem*, which affords an example of our most recent type of cruiser. Putting the weight of the machinery in the three Dutch vessels at 605 tons and the mean maximum horse-power at 10,260, we have 16.9 horse-power developed per ton weight of machinery. If the weight of the *Diadem's* machinery was 1,437 tons, and the horse-power developed 17,262 (see Sir John Durston's paper read at the last meeting of the Institution of Naval Architects), it will be seen that 12.01 horse-power was developed per ton weight of machinery. It must be borne in mind, however, that the *Diadem's* full-power trial extended over eight hours, while that of the Dutch cruisers was but of four hours' duration. If every allowance be made, however, there can be no doubt that the adoption of the express type of boiler gives an enormous advantage in regard to lightness of machinery, and therefore of speed; and it may be said generally that the results bear out the wisdom of the choice of the Dutch naval authorities.—*Engineering*.

SHIPS OF WAR.

[CHILI.]

O'HIGGINS.

The Chilian cruiser *O'Higgins*, which has just completed a series of trials, including twenty-four hours' seagoing speed, six hours' full speed, gunnery, turning, and other trials all of which have been carried through with complete success. The *O'Higgins* was designed by Mr. Philip Watts; the keel-plate was laid in April, 1896; the vessel was launched in May, 1897; and she is now about to leave for Chili, complete in every respect; the period of her completion in less than twelve months from launch is exceedingly short, when her size is considered, and the seven months' engineering strike which intervened is taken into account.

The dimensions of the *O'Higgins* are: Length, 412 ft.; beam, 62 ft. 9 in.; mean draught, 22 ft. At this draught the vessel displaces 8,500 tons, and carries 700 tons of coal, a complete outfit of provisions, stores, fresh water, etc., and all ammunition, torpedoes and equipment. This mean draught was maintained during the speed trials, which were made off the Tyne in the presence of Admiral Uribe and other members of the commission of Chilian officers appointed to superintend the construction of the vessel.

The machinery has been supplied by Messrs. Humphrys, Tennant and Co., and the boilers are of the Belleville type, being thirty in number, placed in three separate water-tight compartments. Owing to a strike of firemen engaged for the trial, the Chilian officers kindly gave the services of 100 Chilian stokers—part of the crew to take over the vessel when complete—and though these men were not accustomed to stoking the Belleville boilers, the trials were nevertheless carried through with complete success, an ample supply of steam being maintained throughout.

The full power of the engines is 16,000 indicated horses, but the twenty-four hours' trial was conducted at about three-fifths full power, and 10,000 indicated horse-power was exceeded during the whole time, giving a speed of over 19 knots. Turning circles were made after the trial to test the manœuvring qualities, and these showed that in 2 min. 6 sec. the O'Higgins could reverse her direction, both engines running full speed ahead, the tactical diameter being 3.4 times the under-water length of the vessel, the complete circle being less than three times her length; the heel of the vessel in turning never exceeded 4 deg.

The above trial was made on April 20, the full-power six hours' trial with natural draught being taken on the 26th. The mean of six runs over the measured mile course, taken consecutively with and against the tide, worked out at 21.52 knots, the last four runs giving a mean of 21.7 knots, which may therefore be taken as the full speed of the O'Higgins. It should be mentioned, however, that the vessel had never been docked since her launch, and though sheathed and coppered, it is probable that a certain amount of slime was adhering to her bottom, and it was afterwards found that numerous copper sheets were dislodged at the launch and repaired in dock after the speed trials.

The gunnery trials were made on two days, and finally completed after the six hours' trial, when, amongst other severe tests, seven guns were simultaneously fired direct ahead by an electrical discharge, no damage to ship or mountings resulting, with the exception of glass. These seven guns were three 8-in., two 6-in. and two 4.7-in. A similar test was applied aft, but with one 8-in., four 6-in. and two 4.7-in. The armament carried by the O'Higgins is not only exceptionally powerful, but is exceptionally well protected, all the four 8-in. guns being separately mounted on 6-in. armored barbettes, three forward and one aft, and protected by armored gun-houses, 7 in. and 5 in. thick, which completely enclose the guns; similar protection is given to the four 6-in. guns mounted on the upper deck. The remaining 6-in. guns—making ten in all—are placed on the main deck, within six casemates whose fronts are 6 in. and rears 5 in. thick. The ten 12-pounders and ten 6-pounders are protected by the ordinary shields, three torpedo tubes are also fitted in the stern above water, and two submerged, one on each broadside. All the armament, it need scarcely be stated, has been supplied from Elswick.

Besides the protection to the guns, the O'Higgins has a 7-in. to 5-in. belt, carried along two-thirds of her water-line, of Harvey armor 7 ft. in depth; this belt is supported on the sloping sides of a complete protective deck, which varies in thickness from 1½ in. to 2 in. The conning tower is of 9 in. armor, and armored tubes are provided for the supply of ammunition to all the guns. The vessel is unusually well fitted in all respects, with electric light and every modern improvement, and is certainly a most powerful addition to the already powerful Chilean navy.—*The Engineer*.

[ENGLAND.]

DIADEM.

The Diadem has been carrying out a further series of experimental trials, having been required to steam for four hours with a view to ascertaining whether she could, with only 78 per cent. of her boiler

heat, obtain the same power as was required of her at her full-power trial on the 26th of January. According to the contract stipulation, she then had to obtain, on eight hours' run, a mean of 16,500 I. H. P., but, as a fact, the mean obtained was as high as 17,188 I. H. P. Drawing 24 ft. 3 in. forward and 26 ft. 6 in. aft, with 291 lb. of steam in the boilers, and with a vacuum of 27.2 in. starboard and 26.3 port, she, on the 29th of January, worked up to 116.2 revolutions starboard and 115.4 port. The conditions of this trial and the previous ones thus offered some striking differences and similarities, for while on the last occasion the whole of the 30 boilers were in use, on the new trial only 24 were lighted up. The draught of water on each occasion, as well as the vacuum, was about the same; the steam in boilers was 291 lb. at both trials, while at the more exacting test there was a slight reduction in the number of the revolutions—namely, from 119.1 to 116.3. On this occasion, however, forced draught was used for the first time, but the air pressure amounted to only three-tenths of an inch, and the total I. H. P. was 8,168 starboard and 7,693 port, giving a collective I. H. P. of 15,861. This result gave a unit of power for less than two square feet of heating surface, which is the forced-draught surface allowed in cylindrical boilers in the Navy. Contrary to the usual practice at forced-draught trials, the coal consumption was taken, and worked out at the exceedingly low average of 1.95 lb. per I. H. P. per hour, thus further showing a considerable gain by the use of the improved Belleville boilers, while the power was easily maintained. The temperature in the stokeholds and engine room was comparatively low, and there was again a marked absence of dense smoke, flame and clinker from the funnels. The trial fully demonstrated that, should one boiler compartment be disabled in action, the design power of the ship could still be reached, and though the trial was limited to four hours, it was evident that the engines and the ship could have stood the test for a considerably longer period. It was also shown by the result of the trial that in no ship has such high evaporative efficiency been realized from the Belleville boiler. At the thirty hours' trial with four-fifths of her power some difficulty was experienced in consequence of the frequency with which the fusible plugs were blown out, but after that trial the faces of the plugs were so hammered out that none were blown from their positions during the trial on the 29th, and thus the use of the distillers for the supply of water to make good the loss of steam was obviated. As stated in previous reports, the ship was remarkably steady, no marked vibration being shown at any speed.

On the 6th ult. the cruiser continued her progressive trials in Stokes Bay. She first made four runs over the measured mile at 16 knots, then four runs at 14 knots, and, after swinging for the adjustment of compasses, four runs at 10 knots. In each set of runs the power and speed corresponded with the results that were anticipated from the model trials at Haslar experimental works. The mean of the first set of runs showed that 6,270 I. H. P. gave her a speed of 15,010 with 4,430 I. H. P., and the third set of runs gave a mean speed of 11.07 knots for 1,923 I. H. P. The trial was regarded as highly satisfactory.

On the 8th ult. she left for a further stage of her experimental trials, and anchored at Spithead the next evening. She first steamed for 15 hours with only eight boilers, and with 270 lb. of steam in the boilers and 250 lb. of steam at the engines. At this stage of the trial the revolutions were 64.3 starboard and 65.1 port, while the collective I. H. P.

was 3,266. The coal consumption worked out at 2.35 lb. per unit of power per hour, which was in fairly close keeping with her preliminary 30 hours' trial with the same power, when the consumption was 2.33 lb. During the second phase of the trial, which also lasted 15 hours, there were 260 lb. of steam in the boilers, but only 150 lb. at the engines. Sixteen boilers, however, were used, and it was found that with 88.9 revolutions starboard and 90.1 revolutions port, and with a collective I. H. P. of 7,119, the coal consumption was 1.94 lb. per unit of power per hour. Both stages of the trial justified the calculations of the Admiralty when the vessel was designed.

The final trial, concluded on the 11th ult., was for 30 hours, with only 24 boilers in use, in order to obtain data as to coal consumption. The draught of water forward was 24 ft. 4 in. and aft 26 ft. 9 in. The steam in the boilers was at a pressure of 265 lb. per square inch, the vacuum being 26.3 in. starboard and 25.7 in. port. The mean of the 30 hours gave 106.5 revolutions starboard and 108 port, and the collective I. H. P. was 12,852. The coal consumption worked out at 1.88 lb. per unit of power per hour. In this trial the vessel developed her maximum continuous steaming power with 78 per cent. of her boiler heating surface, and it was obtained under natural draught conditions, but with the fans moving slowly to ventilate the stokeholds. Although the coal was hand-picked, so much clinker was formed that after the first four hours of the run it was found necessary to clean out the fires every eight hours, but in spite of this drawback all the required results were obtained with only 2.45 square feet of heating surface per I. H. P. There was very little smoke and no flaming at the funnels. The course taken was from Spithead to Hastings, then a long run to the westward as far as the Scilly Islands, and then back to Spithead. The speed was not officially recorded, but the distance of 215 miles between Beachy Head and the Lizard was travelled in 10 hours 40 minutes, giving a speed of fully 20 knots, thus confirming the data obtained on the official runs between Ram Head and Dodman Point. The vessel has throughout the trials been uniformly successful, and though she has been favored, on the whole, with fine weather, she ran into a stiff breeze and a heavy sea early one morning, when her sea-keeping qualities were well tested, with the most satisfactory results.—*Journal of the Royal United Service Institution.*

HERMES.

The Fairfield Shipbuilding and Engineering Company, Glasgow, launched, on April 7, 1898, the second class cruiser *Hermes*, one of two of the same type ordered last spring. The keel was laid down on April 24, so that the vessel, of 5,600 tons displacement, has been launched within a year, notwithstanding the drawback of a fire which destroyed all the machinery and patterns, and delaying the work in the initial stages. This is the second cruiser launched this year, the first having been the 11,000-ton *Argonaut*, and in six weeks they will launch a third—the *Highflyer*; while in the same period they expect to lay the keel of two 12,000-ton armored cruisers, to be called the *Cressy* and the *Aboukir*. It may be interesting to compare the *Hermes* with some earlier second-class cruisers, to show the great progress which has been made under the *regime* of the present technical advisers of the Admiralty.

	"Magicienne."	"Latona" Class.	"Hermes."
	1887.	1890.	1898.
Length between per- pendiculars	265 ft.	300 ft.	350 ft.
Beam	42 "	43 "	54 "
Draught (mean)	17 ft. 6 in.	16 ft. 6 in.	21 "
Displacement	2950 tons	3400 tons	5600 tons
Speed	19 knots	20 knots	19.5 knots
Protection	1½-in. deck Six 6-in. b.-l. guns Nine 6-pdr. q.-f.	2-in. to 1-in. deck. Two 6-in. q.-f. Six 4.7-in. q.-f.	1½-in. to 3-in. Guns, 4½ in. Eleven 4.7-in. q.-f.
Armament	One 3-pdr., One machine One boat gun Two torpedo tubes	Eight 6-pdr. One 3 pdr. Four machine One boat gun Four torp. tubes	Eight 12-pdr. Seven 3-pdr. Four machine One boat gun Two sub- marine tubes.
Normal coal capacity.	400	400	550
Complement.	218	273	450

The design of the *Hermes* in one or two respects introduces improvements on the *Venus* class, of which the *Fairfield* Company built two, and of which in all, nine were constructed, the most notable change being in respect of guns and protection. In the *Venus* there were five 6-in. and six 4.7-in. quick-firing guns, and whereas in the new vessel it has been considered desirable in the interests of uniformity and to secure a larger supply of projectiles to make all the guns of 4.7-in. calibre; these latter fire a 45-lb. instead of a 100-lb. shot; but the difference in energy is not quite so great, the former having a penetration at the muzzle equal to 11.9 in., as compared with 16 in. of wrought iron, but there is a compensating advantage in greater rapidity of fire. In the auxiliary armament there is no change. In the *Venus* there was an armored cofferdam for the protection of the cylinders; but in the new ships the protective deck is raised to suit this change. The table we have given, however, shows the remarkable advance in second-class cruisers in ten years. The *Hermes* is 85 ft. longer than the *Magicienne*, 6 ft. more beam; while the displacement is almost doubled, the draught being increased by 3 ft. 6 in. This difference in weight represents superior qualities in every respect, in armament, in defense, and in radius of action. Some time ago we had occasion to compare the *Doris* with the *Latonia* class (see *Engineering*, vol. lxi, page 776), but the ten years' advance is still more striking.

In the first place, the increased size of the hull gives not only a steadier but a higher freeboard. The guns on the poop and forecastle of the *Magicienne* were 18½ ft. above the water-line; in the *Hermes* they are 28½ ft. above the load-line forward and 19¼ ft. aft. As regards the attack, it will be seen that the new ships are immensely superior. They have eleven 4.7-in. quick-firers, against the six old breech-loaders. Three of the 4.7-in. guns fire ahead in line with the

keel, and three fire aft. The guns on either side are built partly on sponsons on the upper deck level, the bow guns having a radius of 6 deg. abaft the beam, and the after guns of 60 deg. forward the beam. The other 4.7-in. weapons are mounted on the broadside with a large arc forward and abaft the beam. These guns are all protected by 4½-in. armored shields. Two of the 12-pounder guns fire forward and two aft, the others being on the broadside, while the most of the 3-pounder guns are in the military tops. As to the supply of ammunition, the *Hermes* has magazines 58 ft. long in the forward part and 42 ft. aft, in all 100 ft., while in the *Magicienne* the combined length was only 54 ft., 28 ft. forward and 26 ft. aft. The increased beam (9 ft.) also adds greatly to the area of the magazines.

As to protection, there is an armored deck extending right fore and aft, curving 5 ft. below the water-line at the sides, and in the center it rises 1 ft. 6 in. above it. This deck ranges from 3 in. to 1½ in. in thickness, covering the whole of the propelling and steering machinery, boilers, magazines, etc. Reserve bunkers are on the protective deck over the machinery space and, whilst affording a water-line belt of coal protection, they give additional security in the event of damage, as they are subdivided into water-tight compartments. An armored conning tower of Harveyized steel is placed forward, fitted up with the usual means of navigating the vessel and directing operations while in action. The whole of the connections with the conning tower are protected by a steel tube extending to the protective deck. The Harveyized armor for the tower was supplied by Messrs. William Beardmore and Co., Glasgow. Bridges are fitted both at the fore and after ends for navigating the vessel under ordinary conditions, with the usual compasses, steering wheels, etc. Three search-lights are operated from these bridges.

As to the hull, it may be said that it is built of Siemens-Martin steel throughout, on the usual principle adopted in warship construction. There is a cellular bottom extending the full length of the engine and boiler spaces, and before and abaft these the water-tight flats of the magazines, etc., continue the double-bottom construction right to the stem and stern. Under the protective deck the side compartments for the full length of the boiler spaces are utilized for stowing coal, the normal capacity being 550 tons, although this quantity may be doubled by carrying fuel on the protective deck, as already indicated. The hull is subdivided by longitudinal and transverse bulkheads into numerous water-tight compartments, the water-tight doors being worked from the main deck as well as from below. The stern-post, struts, stem and rudder are of phosphor-bronze. The stem is of the usual ram form, and the structure behind is especially strong and efficiently connected to the general framework of the vessel, with a view to the contingency of ramming. The rudder is of the balanced type, and controlled by Harfield's compensating gear below the protective deck. The vessel, being intended for foreign service and long cruises at sea, in which the maintenance of a uniform speed becomes essential, has been completely covered to above the load water-line with teak of a minimum thickness of 3½ in. and coppered. To secure steadiness of gun platform, so necessary in a vessel intended for war purposes, bilge keels 23 in. deep have been fitted for a length of 140 ft.

As to the machinery, it is still more interesting to compare the ship now launched and the predecessors of the same class, the *Marathon*

and Magicienne, built ten years ago, and the Venus and Diana, completed in 1896. The table appended shows the leading dimensions in the respective classes.

	"Magicienne."	"Venus."	"Hermes."
	1889.	1896.	1898.
Diameter of high-pressure cylinders.....	34½ in.	33 in.	26 in.
Diameter of intermediate pressure cylinders.....	56 "	49 "	42 "
Diameter of low-pressure cylinders.....	76½ "	74 "	(2) 48 "
Length of stroke.....	3 ft.	3 ft. 3 in.	2 ft. 6 in.
Indicated horse-power.....	9000	9600	10,000
Steam pressure.....	155 lb.	155 lb.	300 lb. reduced to 250 lb. at engs.
Number of boilers.....	4 double-ended	8 single-ended	18 Belleville
Total heating surface.....	13,600 sq. ft.	18,740 sq. ft.	24,000 sq. ft.
Total grate surface.....	535 sq. ft.	634 sq. ft.	796 sq. ft.
Ratio of grate area to heating surface.....	....	1:29.56	1:30.15
Indicated horse-power per square foot of grate area.....	....	15.14	12.56
Heating surface per indicated horse-power ..	....	1.95 sq. ft.	2.40 sq. ft.
Indicated horse-power per ton of boilers.....	....	17.3	22.2
Indicated horse-power per ton of all machinery.....	....	10.43	11.50

The first striking feature is the increase of steam pressure which has characterized all the ships built during the last four years, and is entirely due to the adoption of the water-tube steam generators. The Hermes has the Belleville boiler fitted with economizers, whereas the Marathon had double-ended multitubular boilers, and the Venus and Diana single-ended multitubular boilers. The result of the increased steam pressure is reflected in the ratio of the volumes of the high- and low-pressure cylinders, which, in the case of the Magicienne, is one to 4.917; in the Venus one to 5.028; and in the Hermes one to 6.81. The Hermes has two low-pressure cylinders to each set of engines, which is now the universal practice in the navy. In the matter of framing and material there has been no important change.

The increase in pressure, and the adoption of water-tube boilers, of course, has had a material influence in the reduction of weight. The total weight of the machinery in the case of the Venus and Diana was 920 tons, and in the case of the Hermes 870 tons; and it will be seen that whereas the Venus only developed 9,600 horse-power under forced-draught conditions, the ship now building will under natural-draught conditions develop a power of 10,000. The reduction in weight is entirely due to the boilers, and notwithstanding the increase of power, the complete boiler installation in the Hermes weighs only 450 tons, against 555 tons in the Venus.

There are 18 Belleville boilers in the *Hermes*, with nine elements in the "steam generator," the tubes in this case being, as is usual, of solid-drawn steel, and 4 in. external diameter; while in the economizers there are nine elements, the tubes being $2\frac{3}{4}$ in. external diameter. The space between the two forms the combustion chamber. In this type of boiler the width of the fire-grate is 8 ft., and the length of the fire-bars is 5 ft. $6\frac{3}{8}$ in. The boilers are arranged in separate compartments, there being six in each boiler-room, arranged athwartships with the tubes running fore and aft; there are three funnels which are carried down to the top of the economizers. In each stokehold there is fitted a Weir's feed-pump, compressed air blowers for supplying air to the furnaces and combustion chambers, and fans for ventilating the stokehold, but the stokeholds are open. The coal bunkers are arranged on either side of the stokeholds, with an athwartship bunker at the forward end.

Turning now to the engines, it may be said that the cylinders are separate and independent castings bolted together, each fitted with a cast-iron barrel or liner, and arranged for jacketing in all cases. The cylinders and valves are arranged as follows, starting from the forward end: Flat slide valve, low-pressure cylinder, high-pressure cylinder, piston valve; piston valve, intermediate-pressure cylinder, low-pressure cylinder, flat valve. The two forward cranks work opposite to one another, and are arranged as close to each other as the centers of the cylinders admit. The other pair are similarly arranged, and have the cranks at right angles to the forward cranks. All the valves are controlled by the usual double-eccentric and link-motion gear. In front the cylinders are supported on forged steel columns, while at the back the usual cast-iron A frame is adopted.

The condensers are of brass and placed in the wings, the steam being condensed outside the tubes. The two centrifugal pumps are of gun-metal, and each is worked by an independent engine, but a cross connection has been arranged so that either or both condensers may be supplied with cooling water from either pump. The feed, bilge and hot-well engines are also independent, and an auxiliary condenser is fitted in each engine-room with separate circulating and air-pump for the auxiliary machinery.

The shafting is of forged steel, the cranks being 13 in. in diameter with an 8-in. hole, the line shafting is 12 in. in diameter with an 8-in. hole, and the propeller length is $14\frac{1}{4}$ in. in diameter with a 9-in. hole. The propellers are of gun-metal, each having three adjustable blades, the diameter being 12 ft. 9 in., and the pitch 13 ft. 6 in., and when running at a speed of 180 revolutions per minute the ship is expected to attain a speed of $19\frac{1}{2}$ knots.—*Engineering*.

EUROPA.

H. M. first-class cruiser *Europa* is one of four vessels which follow, as it were, in the wake of the *Powerful* and *Terrible*, of which the *Diamem* is a type. The two sister ships are the *Niobe* and the *Andromeda*. The latter was launched in April last year at Pembroke, the *Europa* in the previous month at Clydebank, and the *Niobe* at Barrow on February 20th, so that they all took the water within little over two months. They are all of 11,000 tons displacement, 435 feet long by 69 feet beam, with a draught of 26 feet. They indicate 16,500 horse-power, and are propelled by twin screws. Their boilers are of the Belleville type.

The armament consists of sixteen 6-inch quick-firers, fourteen 12-pounder and twelve 3-pounder guns, and three torpedo tubes, two of which are submerged. The guns are protected by $4\frac{1}{2}$ -inch armor, and there is a 4-inch deck armor. The normal coal supply is very large, viz., 1000 tons, and their maximum speed is 20.5 knots. They cost over £560,000 each. There are four other ships in hand very similar to them—the Argonaut, launched at Fairfield in January last; the Amphitrite, being built at Barrow; the Ariadne, at Clydebank; and the Spartiate, at Pembroke. It is expected that these four vessels, which are of the same displacement, will have a greater speed by one-quarter of a knot, gained by running the engines faster.

The Europa left Portsmouth on the 3rd inst. for a thirty hours' run at 12,500 indicated horse-power, and arrived at Plymouth on Saturday night. She drew 24 feet 6 inches forward and 26 feet 6 inches aft. The steam pressure was 265 pounds, and the vacuum 24.8 inches and 25.5 inches in starboard and port engines respectively. The engines developed 12,379 indicated horse-power and 103.8 revolutions with a coal consumption of 1.94 pounds per unit of power per hour. During the trial she made four runs over the deep-sea course between Rame Head and Dodman Point, when, with 103.6 revolutions and 12,441 indicated horse-power, she realized a speed of 19.331 knots. The Diadem, the pioneer ship of the class, built and engined by the Fairfield Company at Glasgow, at her corresponding trial averaged 19.79 knots over the deep-sea course with a coal consumption of 1.59 pounds per unit of power per hour and 12,776 indicated horse-power. After coaling at Plymouth, the Europa left again on Tuesday morning for an eight hours' full-power trial, in which she made two runs over the deep-sea course. She had 279 pounds of steam in her boilers, and with 113 revolutions and 17,137 indicated horse-power she achieved a speed of 20.4 knots, but the mean of the eight hours gave a collective indicated horse-power of 17,010. The Diadem at the corresponding trial, with 17,188 indicated horse-power, gave a speed of 20.6 knots on the deep-sea course.—*The Engineer*.

FURIOUS.

The Furious, cruiser, has completed the second of her coal consumption trials, which was 30 hours at 7003 horse-power. The course was from Start Point to the Scilly Islands, and the runs were made under the best conditions for steaming. The mean results were: Steam at engines, 210 pounds starboard, 210 pounds port; cut-off in high-pressure cylinders, 55 per cent starboard, 54 per cent port; vacuum, 27.8 inches starboard, 27.6 inches port; revolutions, 127.4 starboard, 128.4 port; mean pressure in cylinders—high, 72.2 pounds starboard, 73.3 pounds port; intermediate, 32 pounds starboard, 37.4 pounds port; low pressure, 15.9 pounds starboard, 14.4 pounds port. The indicated horse-power was—high pressure, 962 starboard and 986 port; intermediate, 1113 starboard and 1312 port; low pressure, 1452 starboard and 1330 port; total, 3527 starboard and 3628 port, making an aggregate horse-power of 7155. The coal consumption per indicated horse-power was 2.098 pounds, and the average speed 18.7 knots. In coal consumption and speed the trial was exceedingly satisfactory. The next trial will be at 10,000 horse-power.

The third of the series of trials of the cruiser Furious took place at Plymouth. On this occasion the trial was for eight hours at 10,000 horse-power. Com. R. B. Colmore was in charge. The conditions as regards

sea and weather were again favorable. The following were the mean results of the eight hours: Steam pressure at boilers, 256 pounds, reduced to 231 pounds in the starboard engine and 236 pounds in the port engine; vacuum 28 inches starboard, 27.1 inches port; revolutions 139.3 starboard, 142.3 port; the indicated horse-power was 5178 starboard, 5094 port—a total of 10,272. The average speed was 20.1 knots, which was satisfactory, being slightly better than that attained by the sister ship *Arrogant* on a similar trial a few months ago.—*Engineering*.

THE HOGUE.

The cruiser *Hogue*, which has just been ordered from Messrs. Vickers, Sons and Maxim, of Barrow-in-Furness, will, when ready to leave her builders, be sent to Devonport for completion, and to be permanently attached to that command. The *Hogue* is one of four vessels of the same type recently designed by Sir W. H. White, K. C. B., as an improvement on the *Diadem* class. She will be armored, and of the following dimensions: Length, 440 feet; breadth, 69 feet 6 inches; mean load draught, 26 feet 3 inches; displacement at load draught, 12,000 tons. She will thus be 5 feet longer and have a displacement of 1000 tons more than the *Diadem*, whilst she will be 60 feet shorter and of 2200 tons less displacement than the *Powerful* type of cruiser. The *Hogue* will have an armament much heavier than that carried by the *Diadem*, although the number of guns will be less. The armament, as at present arranged, will consist of two 9.2-inch breech-loading guns, twelve 6-inch and seventeen 6-pounder and 3-pounder quick-firing guns, and two submerged Whitehead torpedo tubes. She will be fitted with water-tube boilers and engines of 21,000 indicated horse-power, and is calculated to run at a speed of 21 knots an hour. Her bunkers will be capable of stowing 800 tons of coal, but this can be doubled if necessary by utilizing the wing and other spaces around the engine and boiler-rooms. The vessel will cost, when complete, about £650,000, of which sum no less than £260,000 will be spent on her by April next. An important feature in her construction will be her armor, this being the first armored cruiser designed since the *Orlando* type in 1885. Her bottom will be sheathed with wood, the material for which will be prepared at Devonport and sent round to the contractors to be fitted in place.—*The Engineer*.

VIOLET.

The new torpedo-boat destroyer *Violet* has completed her second stipulated three hours' 30-knot trial at Portsmouth successfully; the vessel encountered a beam wind, but on the whole the weather was favorable; the mean of the six runs on the measured mile showed that with 381 revolutions and 6600 I. H. P. the vessel had a speed of 30.014 knots; the highest speed attained during three hours was 30.8 knots, and the mean of the entire run was 30.16 knots, which was obtained with 381.2 revolutions and 6630 I. H. P.

FLYING FISH.

The new torpedo-boat destroyer *Flying Fish* had her final steam trial at Portsmouth recently, when, with 6454 I. H. P. and 392.5 revolutions,

she obtained a mean speed on a three hours' run of 30.371 knots; the mean of six runs on the mile was a speed of 30.172 knots, with 390.7 revolutions; after the speed trial the vessel tried her steering machinery ahead and astern, both steam and hand gear being tested, and afterwards she had her starting and stopping trials, all of which were satisfactory.

TERRIBLE.

A further sixty hours' trial of the Terrible, first-class cruiser, was made on the 25th, 26th, 27th and 28th of last month, during her voyage from Portsmouth to Gibraltar, at two-fifths authorized natural draught power. A start was made off St. Catherine's at 2.30 P. M. on May 25th, and terminated at 10.30 A. M. on May 28th, after completion of which the ship was kept running at the same power until she reached Gibraltar in sixty-eight hours. The results, which are pronounced very satisfactory, are given in the accompanying statement:

Report of a 60 Hours' Trial of H. M. S. Terrible at 10,000 I. H. P.

Draught of water.....	Forward 28 ft. 2 in.	Aft 29 ft. 5 in.
Steam in boilers = 230 lb.	Starboard.	Port.
Vacuum	26.6 in.	26.5 in.
Revolutions per minute.....	81.1	81.42
Cut-off in H. P. cylinder, percentage of stroke....	36.4	31.7
Mean pressure—High.....	49.29	57.38
Intermediate.....	23.77	22.14
1st low.....	9.48	9.50
2nd low.....	9.49	9.22
Indicated horse-power—High.....	1568.9	1825.8
Intermediate.....	1798.8	1682.5
1st low.....	846.5	850.9
2nd low.....	847.0	825.9
	5061.2	5185.1
Total power.....	10,246.3	
Total distance run.....	1020 knots.	

The average speed of the vessel was seventeen knots, and the coal consumption per indicated horse-power per hour for all purposes 1.89 pounds, whilst the gross total indicated horse-power developed was 10,246.3.—*The Engineer.*

ARIADNE.

The Clydebank Engineering and Shipbuilding Company, Limited, Glasgow, launched on April 22nd the Ariadne, a first-class cruiser of practically the type of the Europa, which was delivered for trial to the Admiralty a few days ago, and is now being prepared at Portsmouth for sea. The Ariadne is 462 feet 6 inches over all, and 435 feet between perpendiculars; her beam, extreme, is 69 feet, and her displacement 11,000 tons. There is a double bottom the full length of the machinery and boiler spaces, and, fore and aft, steel water-tight magazine flats continue the protection. Above the protective deck over the boiler spaces, and below alongside the boilers, are side compartments for the stowage of coal; and with the cross bunkers there is formed as complete a protection as is possible to the boilers. At the normal draught the coal capacity is 1000 tons, but there is provision for double that quantity of fuel should the necessity of carrying it arise. The subdivision of the hull by longitudinal and transverse bulkheads is exceptionally complete, and with so many water-tight com-

partments the vessel is as nearly unsinkable as a warship may be. In the bulkheads openings have been cut only where they are likely to be absolutely necessary, and the water-tight doors which have been fitted may be worked both on the spot and from the main deck. As is usual in warships that are sheathed, the stem, stern post and shaft brackets are of phosphor-bronze. The hull, up to about 6 feet over the water-line, is sheathed with teak planking, which, when the Dockyard takes the vessel over, will be coppered. There are bilge keels about 210 feet long and 3 feet deep. The rudder is a casting of phosphor-bronze plated with naval brass, and may be worked either by screw-steering gear actuated by duplicate engines, one in each engine-room, or by hand. All the steering apparatus is below the protective deck, which has a thickness ranging from 4 inches amidships to 2½ inches at the ends, extends the whole length of the vessel, and covers completely the machinery, boilers and magazines. The conning tower is of Harveyed steel, and the steering gear, shafting, voice tubes, etc., are protected as far as the protective deck by a steel tube 7 inches thick. The navigating bridges are as in other ships of the navy, but in the *Ariadne* the after one is higher, in order that the view of officers may not be obstructed by other deck erections and fittings. When the vessel is completed her armament will be: Four 6-inch quick-firing guns with shields—two on the upper deck aft and two on the forecastle deck; twelve 6-inch quick-firing guns in armor casements of Harveyed steel—eight on the main deck and four on the upper deck; fourteen 12-pounders and a large number of smaller and machine guns. There will also be two torpedo tubes, discharging under water forward. The complement of the vessel is about 700 officers and men, and, in addition to the accommodation for them, there is a suite of rooms for an admiral. The machinery consists of two sets of triple-expansion engines fitted in two water-tight compartments; each set has four inverted cylinders working on four cranks. The high-pressure cylinder is 34 inches in diameter, the intermediate 55½ inches in diameter, and each of the low-pressure 64 inches in diameter. All are adapted for a stroke of 4 feet. The cylinder covers are of cast steel, and the pistons, of conical shape, are also of cast steel. The high and intermediate cylinders are fitted with piston valves, and the low-pressure with treble-ported slide valves, with a relieving ring at the back, all the valves being worked by the usual double-eccentric and link-motion gear. Reversing is effected by means of double-cylinder steam engines, with gear of the all-round type, hand-gear also being available. The sole plates are of cast steel, and the cylinders are supported by cast-iron columns at the back, and forged-steel columns at the front. The main condensers are at the back of the engines, and constructed of cast brass in oval form; they are fitted with brass tubes ¾ inch in diameter. The condensing water is supplied by four centrifugal pumps of gun metal, fitted with independent engines. Steam will be supplied by 30 water-tube boilers and economizers. The boilers are arranged in four groups, each group fitted in a water-tight compartment. They are designed to work at 300 pounds pressure, reducing valves being fitted to reduce the steam pressure to 250 pounds at the engines.—*Engineering*.

GOLIATH.

On March 23rd the first-class battle-ship *Goliath*, the first keel plate of which was laid on January 4th, 1897, was launched at Chatham. The

Goliath is 390 feet long between perpendiculars, has an extreme breadth of 74 feet, and a mean draught of 26 feet, and her displacement will be about 13,000 tons. This draught gives her a freeboard of 22 feet 6 inches forward, 19 feet amidships, and 19 feet aft. The side protection extends for 196 feet of the middle of her length, and from 5 feet below the water-line to 9 feet above it, the armor plating being of Harveyized steel 6 inches thick, while a belt of 2-inch nickel-steel armor runs right away in a broad streak along the water-line from the citadel to the stem and protects a width varying from 12 feet 6 inches to that of the whole depth of the stem below the main deck. This 2-inch, or 2½-inch, belt, including the skin plating of the ship, represents at least 6 inches of ordinary wrought-iron armor, and will constitute a formidable obstacle to projectiles from small Q. F. guns and is sufficient to burst common shell from guns of large calibre. The bow plating of the Goliath has, however, a very important duty to fulfill, independent of that of meeting the attack of small quick-firers. She has a cigar-shaped snout, and is supported internally by the 2-inch steel-armored deck and the elongated stiffening plate below, the breast hooks lending similar aid near the water-line. In the Resolution all these features are also found, but they are only held together by the steel framing of the ship and by the ordinary skin of 20-pound steel plates. The Goliath, on the other hand, has a double wall of nickel steel supporting the framing, 4 inches in combined thickness, and from 30 feet to 35 feet in depth. This could not possibly be turned aside by impact with the hull of an enemy, but would enter it like a cold chisel, and, after ripping open the plates, its very shape would facilitate the withdrawal of the ram uninjured. The filling in of the 3-foot spaced bulkheads with cork is also an additional safeguard, for it makes the stem a solid but elastic feature right back to the main collision bulkhead. The hollow stems of earlier vessels were always a source of possible danger. Then, again, in the ship now under consideration the double-bottom system is carried forward to the very forefoot itself. The longitudinals of the bracket framing are extended by intercostal portions to frames immediately behind the stem casting, thus preventing any working of the structure or of the armor plates covering it. At both ends of the armor belt rounded armor bulkheads are fitted of the same material, 12 inches, 10 inches, 8 inches and 6 inches thick. The barbettes at the forward ends of the battery are circular in plan, and are armored with Harveyized steel, the upper tier of plates being 12 inches and the lower 6 inches thick. The conning towers are circular in form, and both are 9 feet 6 inches thick. From the base of each tower a forged steel communicator tube of 4 inches internal diameter descends, the thickness of the forward one being 8 inches and of the after one 3 inches, inside of which are led the controlling shafts of the steering engines, engine-room, telegraph rods, and all the important voice tubes. The protective deck between the armored bulkhead is made of two thickness of half-inch steel plates, with additional 1-inch plates on the sloping sides. Beyond the limits of the side armor are a lower deck, protected by two thickness of 1-inch plates. The armament of the ship will consist of four breech-loading 12-inch 46-ton guns, on turntables, in circular redoubts, with all-around loading mountings, made by Messrs. Whitworth & Co., and they will be protected by shields, having 8-inch Harveyized steel in front, sides and rear, the floor plates being of 2-inch nickel steel and the crown plates of 2-inch mild steel. There are also twelve 6-inch Q. F. guns, eight being in 6-inch casemates on the main deck, while four are similarly

protected on the upper deck. The four end main-deck casemates have novel features, in that the guns can fire right forward and right aft respectively. Of ten 12-pounders (12-cwt.), six are placed on the upper deck amidship and four on the main deck fore and aft. Each of the fighting tops of the ship is armed with three 3-pounder Hotchkiss guns, the shelter deck forward with two 12-pounder boat and field guns, and the shelter deck aft, on the boat deck and bridges, with eight Maxim guns and six Howitzer guns. The ship is also fitted with four submerged tubes for 18-inch torpedoes, two on the broadsides forward and two aft. She will carry fourteen 18-inch and five 14-inch torpedoes, these latter for firing with dropping gear from the ship's steamboats.

The propelling machinery of the Goliath, which has been constructed by Messrs. Penn and Sons, of Greenwich, are of the vertical inverted expansion type, the cylinders being 30 inches, 49 inches and 80 inches in diameter respectively, and 4 feet 3 inches stroke. The main and auxiliary condensers in each engine-room are of brass. There are also in the engine-rooms two evaporators and distillers, four fire and bilge engines, four main centrifugal pumps, two hot-well pumps, one drain tank pump, two dynamos and engines. Three main and three auxiliary feed pumps are in the boiler-rooms. The ship is also fitted with two refrigerating machines, capable of reducing the temperature of a chamber of 1800 cubic feet capacity to 15° Fahr. after 12 hours working. Six search-lights are carried, one on the platform high up on each mast and two on each of the bridges. There are six positions for steering by steam, viz., fore-bridge, both conning towers, tower deck forward, and in both steering compartments. There are twin screws, 17 feet in diameter, and arranged so that the pitch can be varied. The I. H. P. of the engines is to be 13,500; speed of ship, 18½ knots. The ship carries 16 boats.—*Journal of the Royal United Service Gazette.*

WOODLARK.

The official two hours' trial of the Woodlark, one of the shallow-draught armed river steamers recently ordered by the British Government, has lately taken place on the Thames. The vessel, which has been built by Messrs. John I. Thornycroft & Co., is 145 feet long and 24 feet broad. The draught of water was not to exceed 2 feet when loaded with 30 tons dead weight, and the speed under these conditions was to be 15 miles per hour. The mean draught of water on trial was found to be 1 foot 11½ inches, and the vessel covered 30¾ statute miles in two hours. She is armed with Q. F. and Maxim guns, and the sides above the water-line and the deck in the wake of the machinery are protected with Cammell's bullet-proof steel plating. The Woodlark is fitted with Thornycroft's twin screw-turbine propellers in raised tunnels, and is the fastest of the gunboats of this class hitherto constructed. Her speed astern was found to be 4¾ miles per hour, and she proved to be under control when going astern.—*Journal of the Royal United Service Institution.*

ANGLER.

The official trials of the Angler, torpedo-boat destroyer, were reported at Chatham on Saturday, April 14th inst., as follow: Speed of ship, 29.879 knots; steam pressure in boilers, 212 pounds per square inch; air pressure in stokeholds, 3.4 inches; vacuum in condensers, 25.7 starboard, 24.8 port;

revolutions per minute, 396.2 starboard, 388.6 port; mean indicated horse-power, 3003 starboard, 2859 port—total, 5862. The consumption of coal per indicated horse-power per hour has not yet been worked out.—*Engineering*.

WOLF.

H. M. S. Wolf has completed her official full-power speed trials on the Clyde, in the presence of the Admiralty representatives. Six runs were made on the measured mile with the following results:

	Steam.	Time.	Speed.
	lb.	min. secs.	knots.
First mile.....	211	1 58½	30.46
Second mile.....	212	1 56½	30.98
Third mile.....	222	1 55½	31.25
Fourth mile.....	215	1 54½	31.41
Fifth mile.....	223	1 55½	31.25
Sixth mile.....	208	1 55½	31.14

The mean speed thus realized was 31.2 knots. After completing the six miles the vessel was taken outside the Cumbræ to complete the three hours' steaming at her contract speed of 30 knots, which was easily obtained, the results at the finish showing a speed of considerably over a quarter of a knot in excess of the contract. After completion of this trial, the usual steering trials at full speed ahead and astern were carried out, and the stopping, starting and reversing of the engines demonstrated for efficiency. The Wolf is the tenth 30-knot destroyer that Messrs. Laird have now completed for the British Admiralty.—*Engineering*.

POWERFUL.

Various and numerous inaccurate statements concerning the performance of the Powerful on her voyage to China have been diligently put in circulation by those who can find no good thing in her. One writer went so far as to say that the port engines will have to be lifted out of her and almost rebuilt. Last week we gave an explicit contradiction to those rumors. Mr. Allan, M. P. for Gateshead, did excellent service on Monday night by putting certain questions about the ship to Mr. Goschen. As far as construction is concerned the replies made by the First Lord of the Admiralty were quite satisfactory. There had been some heating of bearings in the course of a steam trial after leaving Mauritius—we gather that the white metal ran and had to be replaced. For five days the ship ran under easy steam with one screw until the bearings had been re-lined, and since, there has been no trouble. So far so well, but the consumption of coal seems to be very heavy. She had 2800 tons on board when leaving Portsmouth, at Las Palmas she took in 800 tons, at the Cape 2286 tons, at Mauritius 800 tons, at Colombo 2115 tons—or a total of 8300 tons, costing no less than £11,000. We do not know what power she exerted, nor what was her steaming time, all that will come out by-and-by, no doubt; but the figures given work out with rather remarkable results as compared with her trial trip performance. This it is known that the ship can steam 14 knots for about 5000 indicated horse-power. At 2 pounds per horse per hour, this gives us per day, say, 110 tons; this, divided into 8000 tons, gives us, in round numbers, 72 steaming days of 336 miles per day, or, in all, over 24,000 miles—or more than round the

world. This apparently shows that she burns much more than 2 pounds per horse per hour, even after due allowance has been made for auxiliary engines.

GUN AND STEAM TRIALS OF H. M. S. ILLUSTRIOUS.

H. M. S. *Illustrious*, a battle-ship of the *Majestic* class, has completed her trials, and is preparing for commission. The results of the gunnery trials mark a very pronounced step in advance, for as a consequence of the introduction of many mechanical devices, the 12-inch 46-ton breech-loading guns were fired with a rapidity which almost justifies their being classed as quick-firing weapons. The guns are of the ordinary service type, firing an 850-pound projectile at a muzzle velocity of 2367 foot-seconds, equal to an energy of 33,020 foot-tons; and yet so complete is the operative mechanism that the only manual effort involved is the lifting of the charge in halves, each weighing 83 pounds, from the pockets in the loading hoist on to the loading tray. The two guns in the after turret were fired three times in 107 seconds from the first discharge to the last; the time between the second and third rounds was only 49 seconds, and this was accomplished by the ordinary crew from H. M. S. *Excellent* after only two or three days' practice. Doubtless, the ship's own company, when they get accustomed to the work, will improve upon this performance; but, as it is, it means that from the forward and after turret, trained on the enemy, 10,200 pounds of shot can be delivered in 107 seconds, and there is no reason why this rate should not be continued. This, when the energy (396,240 foot-tons) is noted, constitutes a vigorous attack which no ship could survive. While the gun and turret mechanism was designed by the late firm of Sir Joseph Whitworth & Co., at the Openshaw Works, prior to the amalgamation with the Armstrong Company, there is a certain appropriateness in the association of this advance in progress with the name of Armstrong, for it was Lord Armstrong who advocated and introduced the rapid-firing type of gun into naval warfare for guns of lighter calibre. Its immense importance was fully demonstrated during the recent conflict between China and Japan, and now the united firms have attained a like result with guns of large calibre, for, considering the weight of gun and ammunition, the rate of fire attained on these trials may, as we have said, be classed as "quick firing."

As we have said, the 12-inch guns of the *Illustrious* are similar to those in the other ships of the class—of 46 tons, wire-wound, and of Woolwich pattern, with the Woolwich hand-breech mechanism, which latter differs from the type previously employed. The older breech-loading guns, it will be remembered, had a mechanism with two distinct operations—the rotating of the screw plug by a Stanhope lever, and its withdrawal by the operation of a crank handle which first drew the plug to the rear, and afterwards swung the block and carrier ring about the axis pin, clear of the box. The new mechanism has a continuous motion operated by a handwheel, and effects the same functions as the old gear, but in a much shorter time; about 8 seconds when the gun is about the horizontal position, but a longer time is taken when the gun is being run in or out at the same time, or is at elevation.

Two guns of this type are fitted *en barbette* forward and two aft, both with armored protecting hoods, and the mountings for the *Illustrious*, as well as those for the *Cæsar*, were supplied from the Openshaw Works. They resemble in general idea the mountings fitted to the *Barfleur*, *Cen-*

turion, and Renown, and fully described in *Engineering*,* but many modifications have been introduced, and to these special reference may here be directed. The Centurion class carried 10-inch guns, and the operations of loading, etc., were performed primarily by hand gear, whereas in the new ships hydraulic power is used, the weights to be dealt with, both in respect of gun and ammunition being considerably heavier. The point of similarity between the two types of ships is that the shell chamber is carried underneath the gun platform, as described in our article on the Barfleur's gun mounting. The "ready supply" of ammunition is carried in this shell chamber and conducted directly to the loading position by hoists, so that the essential principle of all-round fire and loading at any position of training is maintained. In the Centurion class the weapon was balanced about its trunnions; but in the new ships, with the heavier ordnance, the gun and slide are balanced about the trunnions of the slide, so that the effort of elevating is minimized, a necessity in the case where the hand gear has to be resorted to in the event of any mishap to the hydraulic mechanism. The whole system of mounting, too, is balanced about its centre of rotation to meet the same desideratum. The centre of gravity coincides as nearly as possible with the centre of rotation, so that any heeling of the ship, permanently or temporarily, does not affect the force to be exerted in training the gun.

The powder is carried, as usual, in the magazines, from whence it is brought to the shell chamber by hoists working in a fixed central tube. Other hoists in the same tube bring shell, should the supply in the shell chamber become exhausted. The powder and shells thus brought up the central tube are transferred, as in the case of the ships of the Centurion class, to the hoists in the rear of the guns, which hoists act as loading trays when in their proper position. But in the case of the illustrious the hoists are operated by hydraulic power instead of by hand or electrical power. The transport of shell in the shell chamber is also effected by two hydraulic power cranes, which transfer the shell from the bins or pockets and deposit them upon the loading trays on the upper hoists. The charges brought up at the last moment through the central tube are of sufficiently small weight to be readily handled and quickly transferred to powder pockets in the loading hoists, from which hydraulic rammers on the turntable push the shell and charge into the gun. In the event of the whole hydraulic system being disabled, the guns can still be loaded by hand power, an upper loading position and loading tray being provided for each gun within the hood, and simple means are adopted for hauling the shell from the shell chamber, or the magazine, to this upper loading position, when, as in the case of the Centurion class, they can be pushed into the gun by hand rammers.

The rotation of the turret is effected by hydraulic turning engines, so arranged that when the hydraulic power is cut off from the engine, a powerful brake holds the turning mechanism and prevents further rotation. On the gun platform is an auxiliary hand pump, which can be operated by the gun's crew and thus run the gun in and out, elevate the gun, or open the breech, to which the hydraulic mechanism is applied. The brake system for controlling the recoil of the gun is independent of the run in and out system; the brakes are self-contained and control the recoil very much in the same way as in an ordinary hydraulic recoil mounting, while the run in and out system is connected with the service

* See *Engineering*, vol. lvii, pages 358 and 415.

pressure from the main pumping engines, and serves for manœuvring the gun on its slide in either direction, or this may be done by hand gear, but much more slowly. In this connection it may be stated that the slight break-down in the case of the *Cæsar* a few weeks ago, about which so much was made in the daily press, was not in connection with the general design of the mounting at all. The *Cæsar* had long since successfully passed through her gunnery trials, but on the occasion of the commissioning trials in January, it was decided to try experimentally a new form of valve on the run-out cylinder, but this proved unsatisfactory. The valve fitted on the *Illustrious* differs from the form experimentally tried; and, indeed, the *Cæsar* was fitted with the same valve as the *Illustrious* with equally good results.

In addition to the hand gear for the breech mechanism, hydraulic gear is fitted, the hand gear being arranged so that it can be disconnected. The hydraulic is more rapid in its operation; the breech can be opened or closed when the gun is at its maximum elevation— $13\frac{1}{2}$ deg.—in 5 seconds. Not only so, but the operation of opening or closing can proceed during the period when the gun is being brought to the loading or firing position, which effects a saving in time in the manipulation of the gun. In effect these hydraulic operations render the 12-inch gun with its high ballistic qualities a quick-firing weapon; no effort being involved on the part of the gunner, except in the pulling of the levers, admitting water pressure to the rams operating the mechanism. The control of the mounting is effected, as usual, from two sighting stations, one on each side, to which positions are brought the various levers and handwheels for training and elevating the guns, as well as the automatic sights. The operating levers for controlling the hoists, rammer and running in and out of the gun are conveniently placed in rear of the sighting station of the gun platform within the view and control of the captain of the turret. Auxiliary elevating levers are also provided on the gun platform, and there is a complete duplicate service of hydraulic pressure pipes in addition to the usual central pivot supply.

At the official trials last week several rounds were fired first from the guns in the fore barbette, to test the effect on the decks of the ship. The first shot was fired from the right gun at 80 deg. before the beam, with an elevation of $1\frac{1}{2}$ deg. The left gun was next fired with a reduced charge on the same bearings. In the third round the right gun fired a reduced charge with $\frac{1}{2}$ deg. elevation, and in the fourth round the left gun fired a full charge at $1\frac{1}{2}$ deg. elevation. The fifth and sixth rounds were fired right ahead with about $\frac{1}{2}$ deg. of elevation, and as it was found that no material damage was done to the decks, further trials on this score were deemed unnecessary. The two guns were next fired with the hand gear alone in use, both guns being fired simultaneously, the left gun at extreme depression and the other at extreme elevation. The object of the trials of the two after guns was to determine the time required, and in this respect an unparalleled record was made. The guns were fired simultaneously, and the time which elapsed from the firing of the first to the discharge of the third round was 107 seconds, during which six shots of 850 pounds were fired. For guns of such calibre this may be regarded as extraordinary, and is a speed which has never been approached in any navy. The time between the second and third rounds was 49 seconds, and these results, as we have already stated, were obtained with an ordinary crew from H. M. S. *Excellent* after a few days' drill.

THE NEW ARMORED CRUISERS.

The Admiralty have this week given out the orders for the four armored cruisers which it was decided to build in July of last year, when the treasury made a supplementary grant to the Navy. Messrs. Vickers, Sons and Maxim, Limited, will build one of these vessels at Barrow-in-Furness, the Fairfield Shipbuilding and Engineering Company, Limited, will construct two, and the Clydebank Company, Limited, have been given the contract for the fourth.

The new vessels differ from the eight ships of the Diadem and Ariadne classes in having a side armor for the greater part of the length, and as more powerful machinery is arranged for, the speed will be greater. Their armament, too, will be the same as in the Powerful and Terrible, so that while intended for cruisers they almost rank as battle-ships, and will be able to take a place in the line of battle. The cost, completed, including guns, will work out to about 630,000*l.*, while the Powerful and Terrible cost 750,000*l.*, and the Diadem class an average of about 575,000*l.*; so that in view of the superior qualities over the latter, especially in respect of protection and speed, it will be recognized that Sir William White and Sir John Durston, the two technical officers chiefly responsible, have arranged a type of ship which will not only be efficient, but represent good value for the taxpayer's money, a point never forgotten at the Admiralty. The following table gives a comparison between the three latest types of modern cruisers:

—	"Cressy" Class.	"Ariadne" Class	"Powerful" Class.
Length, between perpendiculars	440 ft.	435 ft.	500 ft.
Beam.....	69 ft. 6 in.	69 ft.	71 ft.
Draught.....	26 ft. 3 in.	25 ft. 3 in.	27 ft.
Weight of hull	7860	6975	8480
Displacement	12,000	11,000	14,200
Side armor	6 in.	—	—
Casemates.....	6 in.	6 in.	6 in.
Protective deck.....	3 in. and 2 in.	4 in. and 2½ in.	4 in.
Armament	Two 9.2-in. B.-L.; twelve 6-in. q.-f.; 17 small q.-f.; two sub. tor. tubes	Sixteen 6-inch q.-f.; 17 small q.-f.; two sub. tor. tubes	Two 9.2-in. B.-L.; twelve 6-in. q.-f.; thirty small q.-f.; two sub. tor. tubes
Indicated horse-power	21,000	18,000	25,000
Speed	21	20½	22
Normal coal capacity *	800	1000	1500

The details of construction are similar in all three types—double-bottom cellular system with longitudinal frames, extending up to the protective deck, or 5 feet below load line, to which the protective deck is connected, and on which the side armor in the Cressy class is constructed, as in all our battle-ships. This double construction gives a great security to the ship. All the ships are sheathed with teak 4 inches thick and coppered.

* The coal supply can be greatly increased, on emergency, to 2000 tons in Cressy and Ariadne, and 2500 tons in Powerful classes.

The armor belt extends for about 230 feet of the length of the ship, and is 240 pounds thick with 4 inches of backing. This belt is 11 feet 6 inches deep, extending 5 feet below and 6 feet 6 inches above the load line, the ordinary shell plating above that being 22½ pounds thick; but as in previous cruisers, all the 6-inch guns are within 6-inch armored casemates. The belt extends to within 120 feet of the stem and 90 feet of the stern, and there extends athwart the ship a bulkhead of 200 pounds in thickness. And here it may be said that all the armor is of nickel steel hardened by the new process, which gives a resistance to penetration by projectiles quite double that possible six or seven years ago, so that the 6-inch armor here is far superior to the 10-inch armor in some comparatively recent ships. The side armor does not, as in all previous ships, terminate at the bulkheads; but is continued, although of less thickness, right to the ram, as in the new battle-ships of the Canopus class. This is of 2-inch nickel steel in addition to the shell plating, so that at least all explosive shells will be kept out of the ship. At the stern, abaft the armored bulkhead, the shell plating is greatly increased in thickness, and the protective deck reinforced with the same object in view. Here the protective deck is 80 pounds thick; whereas within the citadel, formed by the side armor and bulkheads, it is 60 pounds. The main deck is also of more than usual thickness—40 pounds—to assist in protection; while, as usual, the coal bunkers are arranged on either side, from all of which it will be appreciated that while giving adequate weight for a high speed, and without relinquishing one jot or tittle of the elements of strength, the director of naval construction has given a protection equal to our latest battle-ships and superior to nearly all preceding ships. As to the arrangement of decks—protective, lower, main, upper and boat deck—the vessels are all alike; the Powerful and Terrible only have poops.

The main armament consists of two 9.2-inch 22-ton breech-loading guns, each mounted in barbettes, with 240-pound nickel steel hardened, and with a gun shield of 6 inches thickness. These barbettes are within the armored bulkheads, and the 12-inch conning tower, with 3-inch armored communication tubes, is further aft. There are two bridges and two conning towers, one forward and the other aft. These main guns have an arc of training of 135 deg., and will probably have an angle of elevation of 13 deg. For bow fire there is on the main deck a 6-inch gun on either side, and above, on the upper deck, on either side of the forecastle another, so that four 6-inch guns fire in line of the keel to 28 deg. abaft the beam. The 9.2-inch gun aft is on the upper deck—there being no poop, while four 6-inch guns also fire astern to 28 deg. forward of the beam. There are two 6-inch guns firing on either broadside with an arc of 120 deg. In addition, there will be twelve 12-pounder guns, two of which augment the bow fire and two fire astern. There are five other machine guns. There are two masts, but the tops only carry search-lights.

The appearance of the ships will be pretty much the same as that of the Diadem, with four funnels for the four boiler-rooms, each of which is 32 feet 6 inches long, the three after being 44 feet broad with two rows of four boilers, and the forward compartment 34 feet broad with two rows of three boilers. This is practically the same as in the Diadem, and here also special attention has been paid to ventilation, a large number of fans being provided with electric motors.

As to the machinery, the following dimensions may be tabulated:

	"Cressy" Class.	"Ariadne" Class.	*"Powerful" Class.
High-pressure cylinder.....in.	36	34	45
Intermediate-pressure cylinder.. "	59	55½	70
Low-pressure cylinder..... "	68	64	76
Low-pressure cylinder..... "	68	64	76
Stroke	48	48	48
Revolutions.....	120	120	120
Indicated horse-power.....	21,000	18,000	25,000
Number of Belleville boilers.....	30	30	48
Heating surface.....sq. ft.	51,500	45,900	69,453
Grate area..... "	1,650	1,449	2,192
Pressure at boilers..... lb.	300	300	260
Pressure at engines..... "	250	250	210
Weight of machinery.....tons	1800	1550	2250
Indicated horse-power....per ton	11.61	11.8	11.11
Square feet of heating surface per indicated horse-power.....	2.45	2.55	2.77
Indicated horse-power per square foot of grate	12.7	12.4	11.40

The engines are, as in previous cases, to be of the inverted direct-acting type, each set having one high, one intermediate, and two low-pressure cylinders. In the Cressy class one of the low-pressure cylinders is to be placed forward of the high-pressure and the other aft of the intermediate cylinder. The crankshaft will be in two interchangeable parts, each part having two cranks placed directly opposite. The Yarrow-Schlick-Tweedy system is to be adopted in some of the ships. The propellers work inwards, and the starting platform is to be at the centre of the ship. The cylinders will be supported in the front by wrought-steel pillars, the back columns will be cast iron, connected together at the top with suitable tie-plates. The frames for the main bearings will be of cast steel tied together, each set of engines being independent of each other. The valves of the high-pressure and intermediate cylinders will be of the piston type, one to each cylinder. Those for the low-pressure will be of the double-ported flat form (one to each cylinder), with a relief ring at the back. All the valves will be actuated by means of double eccentrics and link motion, separate provision being made for adjusting the cut-off in each cylinder. The valve setting will be arranged so that the power developed by the two low-pressure cylinders combined shall equal that of the high or intermediate cylinders.

Each set of main engines will have one vertical air pump worked by means of links and levers from the high-pressure crosshead. The main condensers are to have a total cooling surface of 21,000 square inches. The two auxiliary condensers will have 3000 square feet of heating surface. There will be four circulating pumps with 48-inch impellers, the duty being 1400 tons from the bilges per hour.

The crankshafts are to be of 19 inches external diameter with a 10-inch

* The designed results are given for comparison. These were exceeded just as the results in the Cressy class may be.

hole, the crankpins of 21 inches external diameter with 12-inch hole, those for the high-pressure and intermediate-pressure engines being 24 inches long, and for the low-pressure, 16 inches. The main bearings are to have a total length of about 14 feet, and the thrust surface will be 2500 square inches. The propeller shaft is to be 19½ inches external diameter, with a 10½-inch hole. The propellers are to be about 18 feet in diameter.

As indicated in the table, there will be 30 boilers of the Belleville type with economizer; the heating surface in the steam-generating tubes will be 33,500 square feet and in the economizer small tubes 18,000 square feet, a total of 51,500 square feet; the grate surface being 1650 feet. The tubes will be solid drawn, 4½ inches external diameter for the generators and 2¾ inches for the economizers. The fans for the stokehold will be of the double-breasted type; 12 of them will be 6 feet 6 inches in diameter and four of them 6 feet in diameter. The two pumps for the hot well will be of the crankshaft type, while there will be eight feed pumps. The capacity provided for feed water is 116 tons. The grease extractor will have 15,750 square inches of filtering area. There will be four fire and bilge pumps having a duty of 100 tons per hour.

Of the other auxiliary machinery, it may be said that there will be four evaporators of 108 tons capacity, two distillers of 54 tons capacity, three electric-light generators, two steering engines, two sets of air-compressing pumps and four reservoirs, two boat hoists, two refrigerating engines of the cold air type, coal hoists, ash hoists, etc., as usual.—*Engineering*.

OFFICIAL SPEED TRIALS OF WAR-SHIPS.

An official return shows the speed trials of warships. Of torpedo destroyers, fifteen have passed successfully through the trials during the past year, one of them being a 27-knot boat, while the others are 30-knot design. Messrs. Laird, of Birkenhead, and Messrs. Palmer, of Jarrow-on-tyne, appear on the list for five boats each, Thornycroft for three, and the Fairfield Company for the fifteenth 30-knot boat. In each case the boats had to run for three hours for speed, and again for three hours at full speed to ascertain the consumption of coal, and it was a condition that should the average rate of consumption exceed 2.5 pounds I. H. P. per hour an extra load would have to be carried in the speed trial, this extra load to be equivalent to the excess in consumption over a given period. Only five out of the fifteen boats seem to have come within the 2½ pounds, the highest rate of consumption having been 2.77 pounds, in the case of one of Palmer's boats; but it is difficult to understand how in the case of Thornycroft's three boats there should be such variation as 2.08 pounds in one case, 2.2 pounds in another, and nearly 2.6 pounds in the third, when all three boats, engines and boilers were the same. The difference is equal to over 1¼ tons per hour, and it is probably attributable only to the stoking. Laird's boats' consumption varies less, between 2.41 and 2.53 pounds per I. H. P., while Palmer's varies between 2.42 and 2.76 pounds. The Fairfield Company's Osprey appears as burning 2.58 pounds per I. H. P. per hour. As to power, this necessarily would be affected by weather, etc., but there are also wide variations. The highest is 6606 I. H. P. for 30.142 knots in the case of Laird's boat, the Panther, but Fairfield is not far behind with 6588 I. H. P., but for this she has the best speed on the list. One or two of the boats, especially those of Thornycroft, got their speed for less than 6000 I. H. P., but for this she has the best speed on the list; the lowest was 5654 I. H. P.

for 30.184 knots. Messrs. Lairds boats range about 6000 to 6200, with the exception already given. The highest speed was got with the Fairfield boat, which made 30.674 knots when developing 6588 I. H. P., and on another trial 30.427 knots for 6412 I. H. P. So that the high power was in their case well justified by events. Palmer's Chamois comes next with 30.396 knots for 6265 I. H. P.

SHIPS UNDER CONSTRUCTION.

The following vessels will be under construction or completing during 1898-99: 12 battle-ships, 16 first-class cruisers, 10 third-class cruisers, 6 second-class cruisers, 10 third-class cruisers, sloops, 4 twin-screw gunboat destroyers.

[FRANCE.]

AMIRAL DE GUEYDON.

The dimensions of the new first-class armored cruiser Amiral de Gueydon, which has lately been commenced at Lorient, are as follows: Length, 448 feet 6 inches; beam, 63 feet; with a displacement of 9515 tons. She will be driven by three screws, and the engines are to develop 20,000 I. H. P., giving a speed of 21 knots. Her Niclausse boilers will be placed before and abaft the engines, the latter being constructed at the works of Chantiers de la Loire at St. Denis. There will be a water-line belt of hardened steel 6 inches thick, extending from the stem to near the stern, which will be closed by a transverse 3-inch armored bulkhead; above the 6-inch belt will be a second narrower belt of 3.9-inch steel protecting the cofferdam; there will also be two armored decks. The armament will consist of two 19.4-centimetre (7.6-inch) guns, of 93-96 model, in turrets, one forward and one aft, with an arc of fire of 270 degrees; eight 16-centimetre (6.3-inch) Q. F. guns of the same model in armored casemates, so arranged that four can fire ahead and four astern.—*Journal of the Royal United Service Institution.*

BOUVET.

The new French battle-ship Bouvet is complete, so far as outward appearances go. She is more like the Carnot than her other nominal sisters, but the similarity is only general and at first glance. In the Carnot the big gun in the side turret stands on a sort of redoubt, in the Bouvet it is balanced on an armored pillar. Probably the construction is identical in each case, and the redoubt of the Carnot may have no protective value—it is one of those things that information is not given away about, and on which the foreigner can only speculate. As it stands in the Bouvet, however, the construction looks singularly faulty; in order to obtain an end-on fire from half the entire armament the guns in question have been placed where quite a medium shell would surely put them out of action for good and all. The two smaller guns that help to fill this nest—they are in little turrets fore and aft of and below the larger gun—would share the same fate; in fine, a rational distribution of armament has been sacrificed in order to obtain an end-on fire—on paper. In action these guns, fired right ahead or astern, would probably blow away smaller turrets that project on the beam and quarter, in any case the blast would make matters singularly unpleasant for the guns' crews. The Bouvet has little in the way of military tops; such as

she has are placed low down; higher up there are only search-light platforms. The stern is built up and quite as high as that of our *Majestic's*; in the *Carnot*, *Martel* and *Massena* it is low. The bow gun is about 30 feet above the water-line. Still higher, on a light superstructure, the 3.9-inch quick-firers are carried; two on each side are directly over the amidships side barbettes, and certainly look as though they would be incommoded in action by the fire of the big gun just beneath them. The new French armored cruiser *d'Entrecasteaux* is practically complete. She is best described as a small edition of the *Charlemagne*—a small edition, that is, in the same sense as our *Powerful* is an adaptation of the *Majestic* type to a cruiser design. The most noticeable feature of the *d'Entrecasteaux* is the arrangement of the funnels, the aftermost of the three being set back by the mainmast, with a large gap between it and the second. The tops of the funnels also have, for a warship, a somewhat eccentric appearance, being much like those of railway locomotives. Some Scandinavian monitors are the only other warships in existence with funnel tops of this inverted bell shape, but in the case of the monitors they are still more pronounced.—*The Engineer*.

[JAPAN.]

ASAMA.

On Wednesday, March 23rd, there was launched from the Elswick shipyard a first-class armored cruiser for Japan. At the luncheon, after the launching had been successfully accomplished, Sir Andrew Noble made a speech, from which we are tempted to reproduce the following extracts, as they explain very fully the characteristics of the vessel and her armament:

The vessel, he said, that they had seen launched by Madame Arakawa was, he ventured to think, a remarkable one. Her length was 408 feet, her breadth 67 feet, her mean draught 24 feet 4¼ inches, and her displacement 9700 tons. Her machinery was of the twin-screw triple-expansion type, built by Messrs. Humphrys and Tennant, with a maximum indicated horse-power of 18,000, while her armament was very powerful, he might say remarkably so. It consisted of four 8-inch breech-loading quick-firing guns, fourteen 6-inch quick-firing guns, twelve 12-pounder quick-firing guns, seven 2½-pounder quick-firing guns, and five torpedo tubes, four being submerged, the latter being the class with which, as he had had occasion before to remark, they had achieved a remarkable success. But if he came to the *Asama's* defensive powers, they were nearly as remarkable. She had at her water-line a belt of Harvey steel 7 inches thick, her citadel was 5 inches thick, whilst her barbettes were 6 inches thick. Her conning tower was 14 inches thick and her casemates were 6 inches thick. Her protective deck was 2 inches thick from end to end. Both in the public press and elsewhere the question of cruisers and armaments had excited much attention of late, and so many comments had been made that he felt impelled to make a few explanatory remarks himself. In the first place, as he had said, the whole of her armor was Harveyed, and they must remember that Harveyed steel was at least equal to one and a half times the defensive power of compound armor. The radius of action of the *Asama* was about 10,000 knots at her most economical speed, and that was more than ample radius of action for the duties she was likely to be called upon to perform. As regards her arma-

ment, perhaps the most convenient way of expressing the Asama's very great power was by comparing her with the armament of the Powerful, which was one of the fastest cruisers in her Majesty's service. The main armament of the Powerful consisted of two 9.2-inch breech-loading guns, twelve 6-inch quick-firing guns, fourteen 6-inch quick-firing guns, and eighteen 12-pounders, whilst the armament of the Asama amounted to four 8-inch quick-firing guns, fourteen 6-inch quick-firing guns, and twelve 12-pounder guns. But they would observe that the whole broadside of the Powerful throws only a weight of shot at a single broadside amounting to 1472 pounds, while the broadside of the Asama amounted to no less than 1775 pounds. They would remember also that the Powerful was a vessel of, he thought, 14,500 tons displacement, whilst the Asama was only of 9700 tons displacement, and her maximum speed was 21½ knots. Turning to the guns, those 8-inch guns of the Asama had a maximum muzzle velocity of 2560 feet per second; but, for reasons which he should come to presently, it was not desirable that that high velocity should generally be used. It was a mistake to suppose that such high velocities were new. That firm had turned out and armed many ships with guns of a velocity of over 2500 feet per second. Further, they made experiments to show that with the new explosives that were now in general use elsewhere, it was possible to get, taking the 6-inch guns as an instance, a velocity of about 3000 feet per second. But it would be in the highest degree unwise to use those very high velocities, except for very exceptional occasions, the reason being that the erosion was so extremely rapid that in a very few rounds the velocity falls off enormously, to the extent of 300 feet or 400 feet, and in comparatively few more rounds the gun becomes unserviceable and requires relining, simply because the surface of the bore is swept away by the heat and pressure of the charge. It was also a mistake to suppose that it was a novelty to fire those high velocity quick-firing guns without the use of brass cartridge cases. The Elswick firm had turned out quick-firing guns of all sizes for some years without cartridge cases. But the point was, perhaps, too technical to dwell upon there. Both cartridge cases and guns without cartridge cases had their defects and had their advantages. With very high velocities it was, perhaps, preferable to dispense with the cartridge case, but that was a question that was open to discussion.—*The Engineer*.

UNITED STATES BUILT CRUISERS FOR JAPAN.

Of the two cruisers being built in the United States for Japan, that under construction at the Union Ironworks of San Francisco, Cal., and soon to be launched, is typical. She is a substantial duplication of the Buenos Aires, built at Elswick in 1895 for the Argentine Republic, with some modifications in armament, and may be said to be a development of the Yoshino. The general features and principal dimensions are: Length on load water-line, 405 feet 2 inches; beam, extreme, 49 feet; normal draught, 17 feet 7.25 inches; normal displacement, 4760 tons; normal coal supply, 350 tons; total bunker capacity, 1000 tons; estimated maximum indicated horse-power, 15,000; estimated maximum speed, 22.5 knots; complement, 405.

The ship has a double bottom extending from bow to stern and reaching well up above the water-line. There are something like fourteen main water-tight compartments, and numerous minor subdivisions. There will be a cofferdam on each side running well forward and aft, but it is

not the purpose of the Japanese to fill the space with cellulose at present. A protective deck, reaching from side to side, and running from the stem to the stern, completely covers the vitals. On the flat portions this deck is $1\frac{3}{4}$ inches thick, but on the slopes at the sides it is increased to $4\frac{1}{2}$ inches. All woodwork is to be fireproofed by the present prevailing electrical process. The ship will be driven by twin screws, actuated by two sets of triple-expansion engines of the four-cylinder type, having cylinders of 40 inches, 60 inches, 66 inches and 66 inches diameter respectively, with a common stroke of 36 inches.

Steam will be supplied by eight boilers, four double-ended and four single ended, having a total grate surface of 792 square feet, and a total heating surface of 22,440 square feet; working pressure about 180 pounds. There are two engine-rooms and four fire-rooms, the latter being closed when under forced draught. The bunkers are so arranged that the coal comes in directly on the fire-room floor.

The principal offensive power of the ship is centered in a very formidable battery of quick-firing rifles. In the main battery there are two 8-inch and ten 4.7-inch rapid-fire rifles; and in the secondary battery there are twelve 12-pounders and six $2\frac{1}{2}$ -pounders. One 8-inch gun is mounted on the forecastle deck, the other on the poop deck, and each has a commanding arc of fire of 270 deg. The gun crews are protected by shields on each piece. These 8-inch guns are of the Armstrong type, and, together with the rest of the batteries, will be purchased in England and placed on board the ship when she reaches Japan. The 4.7-inch guns are mounted in sponsons on the main deck, and are sheltered by shields and the 3-inch sponson armor. The forward gun on each side and the after gun on each side have separately an arc of fire of 130 deg., the forward guns being able to fire dead ahead and the after guns being able to fire dead astern. The rest of the 4.7-inch rifles, and such of the 12-pounders as are sandwiched between on the main deck, have arcs of fire of 100 deg. The 12-pounders have the same 3-inch sponson armor about them. The four remaining 12-pounders are mounted forward and aft in sponsons near the bow and stern. The $2\frac{1}{2}$ -pounders are placed on the hammock berthing and up in the military tops. The 8-inch and the 4.7-inch rifles will be supplied with ammunition by electrical hoists, while the supplies for the smaller guns will be raised by whips from the magazines. A torpedo outfit of five tubes has been called for, two on each broadside and one in the stem, but there is reason to believe the bow tube will be removed. The value of such tubes has long been known to be more than questionable.

The ship will be lighted by electricity, and ventilated by natural and artificial means; and the fittings, so far as consistent with the Japanese regulations, will conform to the best American practice. The contract price is reported to be something like £205,000.—*The Engineer*.

[RUSSIA.]

PERESWIET.

The new first-class Russian battle-ship Pereswiet was launched at the Baltic Works on the Neva in the presence of the Czar and Czaritzza and a large concourse of distinguished spectators, including the members of the foreign Diplomatic Corps and many foreign officers. The keel of the Pereswiet was laid down in November, 1895. Her chief measure-

ments are: Length, 434½ feet; width of beam, 71½ feet; depth below water-line, 26 feet; and displacement, 12,694 tons. She has three screws, and will be fitted with three vertical engines of triple expansion, each calculated to develop 4800 indicated horse-power, with 30 Belleville boilers in six groups, having a total heating surface of 43,418 square feet. The turrets for 10-inch guns are being made at the Nevsky Works, and the carriages for the smaller artillery at the Oboukhoff Works.—*Engineering*.

[SPAIN.]

PELAYO.

The near approach of war has naturally caused the utmost activity in the Spanish Navy, and the most earnest efforts are being made to get every available vessel into commission with the least possible delay. The ironclad Pelayo, at the time the Cuban question reached an acute stage, was in dock at Toulon, where she was being refitted with a new boiler installation, Niclausse boilers being substituted for those already in the ship. In such a crisis no attempt could be made to carry out complete trials; and a full-power trip was the most that could be done, but the conditions under which it was made, and the results given by the new boilers, seem sufficiently remarkable to merit notice.

The pipe work was not completed till the evening of April 6, and up to that time it had only been possible to raise steam in two out of the 16 boilers. Owing to the want of steam pipes the remaining 14 had never even had a fire below them. There was no time to try them, however, and early on the morning of April 7 the Pelayo sailed with all her boilers under steam. In two hours after leaving she attained her full speed of 16 knots with natural draught, all boilers being at work, and she maintained this speed during four hours. The horse-power developed was 8000. The boilers throughout worked satisfactorily, and the pressure was maintained with ease, although the stokers were exclusively Spanish merchant sailors, mobilized in readiness for war, who for the most part had no knowledge of boilers; the complement also was very incomplete.

The results were so satisfactory that the Spanish commissioners decided to accept the machinery at once, and towards four o'clock in the afternoon the Pelayo continued her voyage to Carthagená, after landing the contractors' representatives.

The Niclausse boiler is in use on several other Spanish war vessels, among which may be mentioned the cruiser Cristobal Colon, of 14,000 horse-power, and on many ships of the French and other navies. The run above described well maintains the reputation of its previous performances, the most striking of which was the recent test of the French cruiser Friant, under what were intended to be actual service conditions. It will doubtless be remembered that she was suddenly ordered to leave Quiberon, run to Cape Finisterre at 17 knots, then cruise in the Atlantic for six days and nights at 16 knots, watching for an imaginary enemy, and finally return to Quiberon at 17 knots. This she successfully accomplished without any special preparation. The present performance is, perhaps, even more remarkable, seeing that only two of the boilers had been under steam before; and it speaks well for the quality of material and accuracy of workmanship employed, that the whole 16 worked without hitch at full load from the moment of first lighting the fires under them; while the ease with which the pressure was maintained, in spite of

the utter inexperience of the stokers, is conclusive evidence of the steaming powers of these boilers.

The following is a brief description of the boiler installation on the Pelayo, with leading particulars and dimensions: There are 16 boilers in all, divided into four similar groups, two forward and two aft. The two forward groups are separated from each other by longitudinal watertight bulkheads; and the after groups are divided in the same way. Each group thus consists of four boilers, which are arranged in pairs; the two pairs are placed back to back with no space between, and the fronts run athwartship. This arrangement, which is only possible with boilers permitting all operations, whether of working or overhauling, to be performed from the front, is very economical of space.

It will be seen from the above that each group has two stokeholds, each stokehold serving for two boilers. These stokeholds are very large, because the length of the Niclausse boilers is much less than that of the old cylindrical boilers. Thus the forward and after stokeholds of the two after groups are 20 feet and 8 feet 8 inches wide respectively, and are of the full half-width of the ship; there is a passage from the forward to the aft stokehold in each group 2 feet 2 inches wide between the boilers and the side. The forward and after stokeholds of the two forward groups are 20 feet 9 inches and 8 feet wide respectively. It is evident that a portion of these spaces is available as auxiliary store-rooms, etc., since a width of 7 feet 10 inches is sufficient for the withdrawal of the tubes and other operations. There are two funnels, one for each pair of groups. Each boiler consists of 15 headers, each containing 18 tubes. The tubes are of steel, all lap-welded, except those of the lower rows, which are weldless; their external diameter is 3.2 inches, and their thickness .137 inch; they slope to the rear at an inclination of 1 in 10, and are fixed in the headers by metallic-coned joints, like all boilers of the Niclausse manufacture.

The steam and water drums are 9 feet long and 2 feet 8 inches in diameter, and the headers are attached to them by the ordinary double cone joints. On the top of each drum is a small steam drum 11¾ inches high in which is the intake of the steam pipe. The other end of this pipe is connected to the steam outlet on the drum which supplies the steam pipes both for the main engines and the auxiliary machinery. Within the drums are placed the mud catchers, the guide pipes for the descent of water into, and ascent of steam from such header, two feed pipes, and the cock to which the steam jet used in cleaning the outside of the tubes is connected to the outside of the drums are the safety valves, the "Soupape avertisseuse," water-gauge fittings, pressure gauge, two feed valves—one to the pump on the main engine, the other to the auxiliary pumps—a blow-off cock, a "robinet de plein," and an automatic feed regulator. The bottoms of the headers of each boiler are connected by a pipe with a blow-off cock discharging into the main blow-off. Each boiler has three fire doors, three ashpit doors and two main doors in the front of the headers. For the safety of the stokers, in case of a tube bursting, the fire and ashpit doors open inwards, and consequently close automatically under internal pressure; the fire doors are also balanced.

The following are the principal particulars and dimensions of the installation: Number of boilers, 16; number of furnaces per boiler, 1, total 16; number of heaters per boiler, 15, total 240; number of outer tubes per boiler, 270, total 4320; number of inner tubes per boiler, 270, total 4320; diameter of outer tubes, 3.22 inches; dia-

meter of inner tubes, 1.57 inches; length of outer tubes, 7 feet 1 inch; length of inner tubes, 6 feet 11 inches; grate area per boiler, 53.25 square feet, total 852 square feet; heating surface per boiler, 1760 square feet, total 28,160 square feet; heating surface \div grate area = 32:1; floor space occupied per boiler, 76.25 square feet, total 1220 square feet; grate area per square foot floor space, .7 square foot; heating surface per square foot floor space, 23 square feet; horse-power, 85; water space per boiler, 120 cubic feet, total 1920 cubic feet; steam space per boiler, 25.4 cubic feet, total 4064 cubic feet; number of fire doors per boiler, 3, total 48; number of ashpit doors per boiler, 3, total 48; number of funnels, 2; pressure, 170 pounds per square inch; weight of boilers, including framework, setting, valves and cocks, tubes and headers and drums, 255 tons; weight per square foot of heating surface, 20 pounds; weight per square foot of grate area, 620 pounds; weight of boilers as above, including water and all accessories, 345 tons; weight per square foot of heating surface, 27.4 pounds; weight per square foot of grate area, 900 pounds.

The foregoing particulars possess a special interest at the present time, when the Pelayo will unfortunately be employed on active service.—*Engineering.*

SPAIN'S ARMORED CRUISERS.

The admission of vessels into the category of armored cruisers is governed so much by individual fancy that the term is in many cases very misleading. It might well be divided into at least three subheads, or else abolished altogether, for at present variations are so great that comparisons between ships designated as "armored cruisers" are well nigh impossible. There are cruisers, all called "armored," without any other distinction: (1) With armor on both guns and belt; (2) with armor on belt only; (3) with armor on the guns only. To the latter class the Spanish cruiser Carlos V belongs, but as a general—and quite unreasonable—rule ships with armor for the guns only, like our Powerful, are classed as first-class protected cruisers, while a thin 3-inch belt will dignify them with the title of armored cruiser. If we compare the majority of Spanish cruisers, the Vizcaya and Infanta Maria Teresa class with their battle-ship Pelayo, we see that the sole difference between them is that where the Pelayo has a belt all around her the Vizcayas have a partial belt for three-quarters of their length and bulkheads. The Pelayo has, of course, four big guns against their two, but then she is the bigger ship.

In both cases the guns are identically protected, a narrow barrette, with nothing below save an armored hoist. In each case a thin shield covers the gun breech—a foolish thing probably, since it is just sufficiently thick to burst a shell and far too thin to keep anything out. Before Yalu the Chinese removed these shields from their battle-ships, and there was probably wisdom in so doing, though we must bear in mind that the Japanese have since replaced them in the Chin Yen. Probably, however, the new shields are of tougher armor, but on that no details are available.

We find, therefore, that to all intents and purposes the Spanish Vizcaya class are battle-ships of the second class, slightly armored, it is true, yet with more armor than the Italian Lepanto carries, since that "ironclad" has no belt at all. A vessel which—save that she has a 2-inch armor over the quick-fire guns—is identical to the Italian Lepanto in the arrangement of armor is the Carlos V. She has no belt, but a very thick deck—6-inch—her big guns in fore and aft barbettes alone are armored. The arrange-

ment of guns is, of course, quite different to the Lepanto's, but the "idea" in both ships is similar. This idea is that a belt of coal and cellulose, with a thick deck below it, is quite equal to a heavy belt of armor. So far as protecting the engines goes this is true; and it *may* prove true in other ways. At the best, a belt is only a strip, liable to penetration above and below in a seaway.

The Cristobal Colon could, and no doubt will, "lie in the line" if there is a naval action; she is proof against every sort of shell. Except her and the Pedro d'Aragon, now building, which carry 10-inch guns, all the Spanish armored cruisers carry a couple of 11-inch guns, very good pieces, able to penetrate all the armor on the American battle-ships' guns.

The American armored cruisers are quite different; they are really armored cruisers. Their belts, instead of being 12-inch steel as in the Vizcayas, are of 3-inch steel only; their big guns are only of 8-inch calibre. Now, an 8-inch projectile is quite useless against the belts of the Vizcayas, or against their barbettes, and in engaging such ships shell fire alone could be depended on to do anything. Of course shell fire is the staple attack, but the Brooklyn and New York can do nothing against the Spaniards with their comparatively feeble 8-inch shell that the Spaniards cannot do against them with a far more powerful gun. It is rank heresy maybe, but we cannot but hold that there is a tendency to unduly glorify the small quick-fire gun or the medium-sized 8-inch. The chances of hitting are, of course, greater with the smaller weapon, both from its extra rapidity and its extra numerical quantity; but when the big shot does hit its effect will be, of course, far greater. However, the *métier* of the Spanish and American armored cruisers is quite different, and it is profitless to compare them. Spain's force is really a number of second-class battle-ships—known as "armored cruisers"—and these will be pitted against a much smaller number of first-class American battle-ships. The "many eggs in one basket" is, when all things are considered, the best for battle-ships. America therefore, apart from other considerations, should win. It is not very safe to prophesy anything, but the probabilities are either a "walk over" for one side or else an absolutely indecisive but sanguinary result. There is not likely to be a mean between these extremes.

The other principal data with regard to the vessels referred to above are as follows: The Vizcaya is an armored cruiser, launched at Bilbao in 1891, carrying two 11-inch guns in two barbettes, and ten 5.5-inch guns, besides smaller weapons. Her displacement is 7000 tons, her length 340 feet, breadth 65 feet, and maximum draught 21 feet 6 inches. She is propelled by twin screws, her engines developing 13,000 horse-power. Her normal coal supply is large, namely, 1200 tons, sufficient to take her nearly 10,000 miles at 10 knots. Her maximum speed is 21 knots. With the exception of the Pelayo, she and the vessels of the same class are the most heavily armored in the Spanish navy. They have belt armor 12 inches thick, extending from bow to stern, but tapering off at the extremities; their big guns are protected by 10½ inches of armor, and the deck plating is 3 inches thick. The Infanta Maria Teresa, also built at the same time and in the same yard, develops rather more power, but is armed and protected in the same way, and is of the same dimensions. Both ships have six torpedo tubes. The Almirante Oquendo, Cataluna, Cardenal Cisneros, and Princesa de Asturias are all very nearly the same in dimensions, and all carry the same guns and armor, so that these six ships form a valuable squadron, and as the slowest of them can steam

20 knots, they ought, if combined, be able to give very good account of themselves.

The Cristobal Colon, originally Giuseppe Garibaldi II, is of rather less displacement—6840 tons—and indicates 14,000 horse-power, but makes only the same speed as the Vizcaya class. Her main armament consists of two 10-inch guns and ten 6-inch, and six 4.7-inch and four torpedo tubes, so that she is powerful in this respect. She is protected by a 6-inch belt of Harveyed steel, and her guns are similarly provided. Her deck plating is $1\frac{1}{2}$ inches thick. Her normal coal supply is 1000 tons. She was launched at Sestri Ponente in 1896.—*The Engineer*.

[UNITED STATES.]

KEARSARGE AND KENTUCKY.

The U. S. battle-ships Kearsarge and Kentucky were successfully launched from the yards of the Newport News Shipbuilding Company on March 24. The Kearsarge was christened with a bottle of champagne, the Kentucky with water from a cut-glass bottle, but several enthusiastic Kentuckians hurled some bottles of good old whiskey against the sides of the Kentucky at the same time. The following are some of the principal facts concerning the ships: Each of the vessels is 385 feet long, 72 feet 2.5 inches beam, 14 feet 3 inches freeboard forward, and 12 feet 3 inches freeboard aft. Their draught, with 410 tons of coal on board, is $23\frac{1}{2}$ feet; their displacement is 11,525 tons. In their turrets they will each have four 13-inch and four 8-inch guns. There will be four torpedo tubes, two on either broadside. The armor will be of solid nickel steel, Harveyized. The lower part of protection will have armor 15 inches in thickness. The armor of the turrets will also be 15 inches, except immediately in front, where it will be made 17 inches. In addition to these heavy guns a battery of fourteen 5-inch rapid-fire guns, a numerous battery of smaller 6-pounder and 1-pounder guns will be carried, such guns being placed wherever they can fire to advantage. The protection of the hull to the water-line region will be effected by means of a side armor belt of a maximum thickness of $16\frac{1}{2}$ inches, with a mean depth of $7\frac{1}{2}$ feet, so disposed in reference to the load line that the vessel with 410 tons of coal on board will have $3\frac{1}{2}$ feet of this belt armor above the water, and with 1210 tons of coal on board will have 2 feet above the load line. The belt will extend from the stem to the after barbette, and will maintain the maximum thickness from the after end of the belt to the forward boiler-room bulkhead, whence it will taper gradually to a thickness of 4 inches at the bow. The conning tower will have armor 10 inches thick, with a tube 7 inches in thickness leading down to the armor deck for the protection of the voice pipes, telegraph, steering rods, etc. The vessels will be driven by triple-expansion engines actuating twin screws, the engines having a collective horse-power of 10,000 when making about 120 revolutions a minute. Five boilers, three double-ended and two single-ended, in four water-tight compartments, will generate the necessary steam at a pressure of 180 pounds to the square inch. The vessels will carry a supply of coal of 1210 tons.—*Engineering*.

ALABAMA.

The United States battle-ship Alabama, the first to take the water of the three new vessels of her type, was successfully launched at noon on

Wednesday, May 18, from the yard of the William Cramp & Sons Ship-building Company, Philadelphia. The naming ceremony was performed by Miss Morgan, daughter of the senior Senator from Alabama. The building of the Alabama, as of that of her sister vessels, the Illinois and the Wisconsin, has been delayed over a year by the failure of the last Congress to make provision for the supply of their armor plate. Otherwise the battle-ship would now have been fitting out for service instead of being launched.

The general dimensions of the Alabama are as follows: Length over all, 374 feet; breadth, 72 feet; freeboard forward, 20 feet; freeboard abaft the after turret, 13 feet 3 inches; draft, 23 feet 6 inches; displacement, 11,525 tons. The guaranteed speed is to be 16 knots and the estimated horsepower 10,000. The main battery consists of four 13-inch guns in two turrets and fourteen 6-inch rapid-fire guns, of which ten are mounted on the gun deck—eight in broadsides between the turrets and two forward of the fore turret, to fire straight ahead—and four are mounted in a small redoubt on the casemate deck, two on each side. The secondary battery embraces seventeen 6-pounder rapid-fire guns, six 1-pounder rapid-fire guns and four gatlings.

The armor, armament and speed of the Alabama, with a displacement of 11,525 tons, compare favorably with that of the latest type of battle-ships built abroad with a displacement of 15,000 tons. The maximum thickness of armor on the water-line is 16½ inches, tapering to 9½ inches at the bottom of the belt. The casemate armor is 5½ inches thick and the superstructure armor is of the same thickness. The armor of the 13-inch gun turrets is 15 inches thick, except the port hole plate, which is 17 inches. The armor of the barbettes on which the turrets rest is 15 inches thick. The thickness of the protective deck armor on the flat over the citadel amidships and also forward and aft is 2¾ inches, and the thickness of the slopes forward and aft of the amidship citadel is 4 inches. The conning tower is cylindrical and 18 inches thick. The total weight of armor and bolts is 2720 tons and the protective deck armor 593 tons. The weight of armament with normal supply of ammunition, which is two-thirds of the full war supply, is 864 tons. The two engines of the Alabama will be of the vertical three-cylinder type, operating twin screws. She will be equipped with eight single ended boilers, placed athwartships.—*Iron Age*.

U. S. S. NEW ORLEANS (AMAZONAS)

The United States Government have been buying or trying to purchase ships of war in various directions, and with varied success. The Brazilian Government have sold two, probably at a considerable profit, namely, the Amazonas and her sister the Almirante Barroso. The former has been lying off Gravesend all the week.

The Amazonas was built at Elswick, and is a very fine vessel. She has a displacement of 3600 tons, is 330 feet long, 43 feet 9 inches beam; her mean draught is 16 feet 10 inches, her horse-power 7000; she carries for her size a tremendous armament, including six 6-inch quick-firers, four 4.7-inch quick-firers, ten 6-pounders, four Maxims.

A 3-inch protective deck extends from stem to stern, and additional protection to the machinery and boilers is afforded by the reserve longitudinal bunkers, which carry coal to a height of about 6 feet above the water-line. The Amazonas attained a speed of 20 knots with natural

draught, and 21.05 knots with forced draught. The gun positions are protected by $4\frac{1}{2}$ -inch armor. A very powerful fore-and-aft fire can be obtained, as two of the 6-inch guns are in shields on the poop and fore-castle, and the other four are sponsoned out, two forward and two aft. The 4.7-inch guns are carried in recessed ports, so as to be clear of the fire of the larger pieces. The ammunition is supplied through hoists worked by electric motors.—*The Engineer*.

FEATURES OF THE NEW BATTLESHIPS.

Secretary Long has just published a circular which defines the characteristics of the three seagoing coastline battle-ships authorized by the new naval appropriation law. It is proposed that the new ships shall have a load water-line of 368 feet; the breadth at water-line will be 72 feet; and the mean draught at the normal displacement $23\frac{1}{2}$ feet; the normal displacement is to be 11,500 tons and the total coal capacity 1200 tons. The hull is to be of steel, with a double bottom, and is to be subdivided by watertight compartments. The hull at the water-line is to be protected by an armor belt of a maximum thickness of not less than $16\frac{1}{2}$ inches and a mean depth of 7 feet 6 inches. This belt is to extend at least from the stem to the after barbette and to maintain the maximum thickness through the engine and boiler spaces. From the boiler space forward it may be tapered to a uniform thickness of 4 inches. The transverse armor just forward of the boiler space and at the after end of the belt will not be less than 12 inches in thickness. Throughout the length of the vessel a protective deck is to extend. Where this deck is worked flat the total thickness will not be less than $2\frac{3}{4}$ inches, and where worked with inclined sides the slope will be 3 inches in thickness forward and 5 inches in thickness aft. A cellulose belt is to be fitted along the sides for the whole length of the ship. The barbettes for the 13-inch guns will have armor 15 inches thick, except in the rear, where it will be reduced to 10 inches. The turret armor is to be 14 inches throughout. The ship's sides, from the armor belt to the main deck, will be protected by not less than $5\frac{1}{2}$ inches of steel armor from barbette to barbette. Coal is to be carried back of a portion of this $5\frac{1}{2}$ -inch casing armor.

In a suitable position will be a conning tower of not less than 10 inches in thickness, having an armored communication tube 7 inches in thickness. Four 13-inch guns will be mounted in two heavy barbette turrets on the midship line, one forward and one aft. There will be ten 6-inch rapid-fire guns in broadside on the main deck, four on the upper deck within the superstructure, and a secondary battery of twenty-four rapid-fire and machine guns. The 6-inch guns on the upper deck will be protected by $5\frac{1}{2}$ -inch armor. There will be two submerged torpedo tubes. The torpedo compartment will be fitted up for the storage of eight 17-foot torpedoes and appliances and means for operating and handling the same.

The vessels will be driven by twin screws. The engines will be of the vertical triple-expansion four-cylinder type, two in number, one on each shaft, and they will be placed in separate watertight compartments. The eight boilers are to be cylindrical and single ended. They are to be placed in four separate watertight compartments, and will work at a pressure of 210 pounds. If on trial the average speed shall equal or exceed the speed at sea of 16 knots an hour for four consecutive hours, the vessel will be accepted as far as the speed is concerned. If the speed

falls below 16 knots and exceeds 15 knots an hour, the vessel will be accepted at a reduced price, the reduction being at the rate of \$25,000 per quarter-knot, if the deficiency of the speed lies between 16 knots and 15½ knots, and at the rate of \$50,000 per quarter knot between 15½ knots and 15 knots. If the speed falls below 15 knots an hour the vessel will be rejected or accepted at a reduced price. No sail will be carried, but two military masts are to be fitted with fighting tops.—*Scientific American*.

THE DESTROYERS AND TORPEDO BOATS.

The Naval Construction Board has prepared the specifications of the proposed destroyers and torpedo-boats to be built in accordance with the authority conferred by the naval appropriation act. Twenty-eight boats—16 torpedo-boat destroyers and 12 torpedo-boats—will be built and bids will be invited on the basis that the destroyers shall be of not less than 400 tons nor more than 435 tons displacement, capable of making a speed of not less than 30 knots an hour, and that the torpedo-boats shall not be less than 150 nor more than 170 tons displacement, capable of making a speed of not less than 26 knots an hour. One of the most important requisites of the proposed vessels is that the destroyers shall be able to make a high speed in a heavy seaway and torpedo-boats a high speed in a moderate seaway. The disablement of the boats is guarded against by a provision that the engines and boilers shall be in separate compartments. The destroyers are to have a minimum coal capacity of 100 tons, which will give them a steaming radius of 5000 miles. The torpedo-boats will have a coal capacity of 40 tons, and their steaming radius will be about that now possessed by the torpedo-boat *Porter*, which is with the division of the North Atlantic Squadron near Porto Rico.

The torpedo-boats are to be supplied with an unusually formidable armament. They are to be equipped with 3-pounder semi-automatic rapid-firing guns and three torpedo tubes, while the destroyers will be given batteries including two 12-pounder and five 6-pounder semi-automatic rapid-fire guns and two torpedo tubes. The total cost of each destroyer is fixed at \$295,000 and of each torpedo-boat at \$170,000. A balance of \$140,000 will remain from the appropriation to meet minor expenses incident to the preparation of plans and other details for the proposed vessels. The contracts will provide penalties for each quarter-knot below the contract requirement and for every day's delay beyond the time limit to be fixed. It is proposed that the destroyers shall be furnished to the Government within 18 months and the torpedo-boats within 12 months.—*Iron Age*.

NEW MONITORS.

Plans are being rapidly pushed by the board for the monitors whose construction is authorized by the naval appropriation act. The designing of these vessels is proceeding under the direction of Chief Naval Constructor Hichborn. On account of the small appropriation made by Congress for each of these vessels—\$1,250,000—it has been determined to limit their size to 2500 tons displacement, and to supply each ship with a single turret to be placed in the forward part of the vessel. It has not been definitely decided whether to equip them with two 12-inch or two 10-inch breech-loading rifles. The superstructure of the vessels will ex-

tend from the turret nearly to the stern, and rapid-fire guns will be placed on this to be directed against torpedo-boats that may attempt to attack the ships. The turret will be so arranged that the guns can be trained over an arc of at least 300 degrees, so that they can be fired in almost any direction except dead astern. These vessels will not be as efficient as the double-turreted monitors, but they will be very effective harbor defenders, and the Department proposes to make them as powerful as possible with the money granted by Congress. They will probably require two years to build.—*Iron Age*.

HOLLAND SUBMARINE TORPEDO BOAT.

It is reported that this boat recently made a run of one and a half miles under water, remaining under the surface for twelve minutes. This is the longest run under water which the boat has yet made, and it is stated that she behaved herself very satisfactorily in every respect. A few of the leading particulars of this vessel will be of interest. She is 55 feet long, 10 feet 3 inches in diameter, and of 75 tons displacement. The steel hull is cigar-shaped, and the boat is propelled by a single propeller. The motive power equipment consists of a 50 horse-power gasoline engine and dynamo, the latter being directly coupled through a clutch at each end of its shaft to the propeller shaft and to the gas engine respectively. A storage battery of 60 special type chloride accumulators is installed, the total weight of the battery being 45,000 pounds. The cells are constructed of steel, lined both inside and out with lead, and are stated to be capable of discharging at 300 amperes for six hours or at 1000 amperes for half an hour. The arrangement of gearing permits of the propeller being run by the engine or of the cells being charged, except, of course, when the boat is submerged, when the motive power is supplied from the cells to the dynamo as a motor. Enough fuel is carried in the cellular bottom to propel the boat on the surface for 1000 miles at eight knots. The dynamo is a 50 nominal horse-power machine, weighing 3500 pounds; the armature speed is 800 revolutions per minute; there are two commutators and a double-wound armature; an overload to 150 horse-power is possible without detriment. The normal speed of the Holland is nine knots, at an expenditure of 50 horse-power. A 10 horse-power motor with a 7 horse-power Ingersoll air compressor is installed for supplying air at 2500 pounds pressure to the reservoirs. The compressed air is used to propel the torpedoes, emptying the water ballast tanks, steering and for supplying respiration. A $\frac{1}{2}$ horse-power motor is used to force the foul air into the water when the craft is submerged, and another of the same capacity to ventilate the battery when charging. The boat is caused to sink by an alteration of the pitch of horizontal diving rudders. When above the surface the craft is steered by observation through the port holes of the conning tower; when below the surface, or nearly so, by compass or by a camera-lucida arrangement fitted in a tube. The Holland's armament consists of an 18-inch torpedo tube opening at the bow of the boat, and three Whitehead automobile torpedoes are carried aboard. There is also an 8-inch aerial torpedo gun at the bow, and pointing aft a submarine gun, both of the latter capable of discharging 80-pound dynamite shells at high velocities. All the guns operate by compressed air, and can be discharged when the boat is submerged. The crew consists of five men.—*The Engineer*.

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JUNE 18. The Marines in Cuba.

BULLETIN OF THE AMERICAN GEOGRAPHICAL SOCIETY.

VOL. XXX, No. II, 1898. Frobisher Bay Revisited. Origin of the Cliff Dwellings. Recent Advances in Geographic Knowledge, Accomplished by the U. S. Hydrographic Office. Copper River as a Route to the Yukon Basin. Some Observations on Prisons in Vladivostock and Sakhalin.

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MARCH AND APRIL, 1898. Pack Saddles and a Powerful Mountain Gun. Concerning the Reliability of Range-finding Shots. Shrapnel Fire from Field Howitzers and Mortars. Howitzers and Mortars for Field Artillery to Supply a Need of Curved Fire. History of Sea-coast Fortifications of the United States, V. Early Fortifications around New York City. An Apparatus for Pointing by Means of an Elevated Line of Metal, Automatically Finding Concealed Position.

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

MAY, 1898. The Infantry of Our Regular Army. Our Volunteer Armies. The Military Shoe. Water: Its Pollution and

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JOURNAL OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

MARCH, 1898. Steel Concrete Construction. The Construction of the Lorain Dry Dock and Shipyard of the Cleveland Shipbuilding Company.

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JUNE. Reservoir System of the Great Lakes of the St. Lawrence Basin; Relation to the Problem of Improving the Navigation of these Bodies of Water and their Connecting Channels.

JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

MAY, 1898. The Submarine Torpedo-boat Plunger. Status of Boards on Changes as Usually Constituted under the Contracts for Construction of Our New Navy. Oil Fuel Experiments on Hydraulic Life-boat Queen. Economy of Electric Lamps. Novel Arrangement of Feed-water Heater in Water-tube Boilers. Recent Trials of the Cruiser Diadem. Nickel Steel for Crank Pins and Axles. The Yarrow-Schlick-Tweedy System of Balancing Engines. Experiments on the Effect of Direction of Turning in Twin Screws. The United States Torpedo-boats Talbot and Gwin. The U. S. Torpedo-boat Morris.

JOURNAL OF THE U. S. CAVALRY ASSOCIATION.

MARCH, 1898. Prize Essay: The History of the Cavalry of the Army of the Potomac, Including that of the Army of Virginia (Pope's), and also the History of the Operations of the Federal Cavalry in West Virginia during the War. Patrol Duty. The Supply of Small Arm Ammunition to Troops in the Field. The Annexation of Hawaii; Some of its Military and Economic Advantages.

JOURNAL OF THE ASSOCIATION OF ENGINEERING SOCIETIES.

FEBRUARY, 1898. Modern Gas Engineering. History of the Stone Arch.

MARCH. Effects of Heating and Working on Iron and Steel.

MAY. The Steel Frame of the St. Louis Coliseum.

JOURNAL OF THE FRANKLIN INSTITUTE.

APRIL, 1898. The Specific Heat of Anhydrous Liquid Ammonia.

JUNE. The Right to Property in an Idea. Recent Improvements in X-Ray Tubes.

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MARCH 24. The Purchased Brazilian Cruisers. A Great Fuel Oil Plant. Army and Navy Purchases.

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MAY 19. The Dupont Power Hammer. The New General Electric Slow Speed Motors. New Rules for Marine Boiler Construction. Army and Navy Matters.

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MARCH 26. The Efficiency of the Water-tube Boiler. Our Maritime Commerce. New Naval War Game. Conning Tower of the Gunboat Helena. Our Recently Purchased Warships.

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JUNE 11. The Santiago Campaign. Smokeless Powder. Steel Wire Guns. Our New Thirteen-inch Guns.

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JUNE 25. Features of the New Battle-ships. Boilers and Bulkhead Doors of the Chicago. Statistics as to Bombardments. Bulkhead Doors. Reconstructed Cruiser Chicago. The New Naval Academy. Carrier Pigeons in War. Proper Care for Our Soldiers. Care of the Wounded in Naval Warfare.

SEABOARD.

MARCH 19, 1898. The New Foreign-built Cruisers Purchased by the United States.

MARCH 24. American Warship Building Resumed. Mammoth Dry Dock at Newport News.

THE SCHOOL OF MINES QUARTERLY.

JANUARY, 1898. An Introduction to the Study and Experimental Determination of the Characters of Crystals. Electrical Engineering at Columbia University.

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UNITED SERVICE GAZETTE.

MARCH 12, 1898. The Navy Estimates. The Disaster to the Maine.

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MARCH 26. The Buying of Warships. The Navy League and the Estimates. The Navy as a Career.

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MAY. Second Prize Essay. The Protection of Commerce During War. The Battle-drill of Infantry. Continental Regulations for the Transport of Sick and Wounded by Rail.

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ENGINEERING.

MARCH 13, 1898. Messrs. Schneider and Co.'s Works at Creusot, No. X. The North German Lloyd T. S. S. Kaiser Wilhelm der Grosse. Air-compressors and Exhausters at the Brussels Exhibition. The Navy Estimates. Proposed Canal from American Lakes to the Atlantic. The Melting Point of Alum-

inum. The First Steam Launch. The Luminous Power of French Lighthouses.

MARCH 18. Messrs. Schneider and Co.'s Works at Creusot, No. XI. The Maxim Gun, No. III. Gun and Steam Trials of H. M. S. Illustrious. German Shipping and Shipbuilding. The Thornycroft Boiler and Feed Regulator. Steam Separator.

MARCH 25. Messrs. Schneider and Co.'s Works at Creusot, No. XII. The North German Lloyd T. S. S. Kaiser Wilhelm der Grosse. The New Armored Cruisers. The Hardening of Steel. Circulation in Water-tube Boilers.

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APRIL 8. Messrs. Schneider and Co.'s Works at Creusot, No. XIII. The Institution of Naval Architects. The North German Lloyd T. S. S. Kaiser Wilhelm der Grosse. Recent Trials of the Cruiser Diadem.

APRIL 15. The Institution of Naval Architects. Messrs. Schneider and Co.'s Works at Creusot, No. XIV. The Paris Exhibition of 1900. European Powers in the Far East. New Second-class Cruiser Hermes.

APRIL 22. Messrs. Schneider and Co.'s Works at Creusot, No. XV. The North German Lloyd T. S. S. Kaiser Wilhelm der Grosse. H. M. Second-class Cruiser Hermes. The Destruction of the Maine. The Spanish Battle-ship Pelayo. The Paris International Exhibition. Circulation in Water-tube Boilers. Coppering Ships. The Destruction of the U. S. Battle-ship Maine. Early Marine Engineering in the United States.

APRIL 29. Messrs. Schneider and Co.'s Works at Creusot, No. XVI. American Naval Intelligence. High Explosives in Naval Warfare. The Paris International Exhibition. The Destruction of the Maine. Coppering Ships. Aluminum Castings. Submarine Torpedo-boats. Shipbuilding for Japan.

MAY 6. Messrs. Schneider and Co.'s Works at Creusot, No. XVII. The Taylor Hydraulic Air-compressor. The Maine Disaster. Coppering Ships. Steel Plant in France. On the Resistance to the Motion of Solids in a Fluid. Explosion of a Chemical Still.

MAY 13. Messrs. Schneider and Co.'s Works at Creusot, No. XVIII. North German Lloyd T. S. S. Kaiser Wilhelm der Grosse. Electric Generators. The Maine Disaster. Straight Line Boiler Diagram. Power Absorbed by Skin Friction and Wave-making. Boiler Explosion near Walsall.

MAY 20. Messrs. Schneider and Co.'s Works at Creusot, No. XIX. Vickers Guns. The New Electric Lighthouse of Pen-

march-Eckmuhl (Finisterre). Executive Rank in the United States Navy. The Sea Power of Japan. Taylor's Hydraulic Air-compressor. The Maine Disaster. Boiler Explosion at Wednesbury.

MAY 27. The North German Lloyd T. S. S. Kaiser Wilhelm der Grosse. The Destruction of the United States Battle-ship Maine. Messrs. Schneider and Co.'s Works at Creusot, No. XX. Electric Generators. The Chilian Cruiser O'Higgins.

JUNE 3. Messrs. Schneider and Co.'s Works at Creusot, No. XXI. The Destruction of the United States Battle-ship Maine. The Haythorn Water-tube Boiler. Trials of Dutch Cruisers.

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JUNE 17. The Paris Exhibition. Messrs. Schneider and Co.'s Works at Creusot, No. XXIII. The Destruction of the United States Battle-ship Maine.

THE ENGINEER.

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MARCH 11. The Naval Estimates. Curious Troubles with Slow-burning Powder. H. M. S. Powerful. Boiler Tubes and the Admiralty.

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MARCH 25. Spain and the United States. Armor Plating of the Canopus. Shipbuilding and Marine Engineering on the Thames in the Victorian Era, No. XIV. The United States Battle-ship Maine. H. M. S. Goliath. The Future of the Sailing Ship. The Armored Cruiser Amazonas.

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MAY 13. Shipbuilding and Marine Engineering on the Thames in the Victorian Era, No. XVII. Trials of the Terrible. Preliminary War Expenses in the United States. The Montgomery-Moore System of Controlling Water-tight Doors.

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THE STEAMSHIP.

MARCH, 1898. Thames-built Electric Launches. Marine Boiler Explosions. Petroleum Fuel Trials. Bromell's Simplex Tube Cleaner. Improvements in Feathering Propellers and Reversing Gears. Relative Advantages of Triple and Twin Screws. Northeast Coast Institution of Engineers and Shipbuilders. The Reeves Patent Twin Feed-water Filter. Defects in Propeller Shafts. Hulme and Lund's Marine Pumps. Floating Docks. Modern Engineering in the Far East. Electric Turret-turning Gear for Warships. Trials of the Cruiser Diadem. Thermodynamics of the Steam Engine. A New Departure in the Testing of Metals. The Fastest Armorclad in the World. Instrument for Gauging the Circularity of Boiler Furnaces and Cylinders. Hon. C. A. Parson's New Design of Steam Turbin.

APRIL. Launch of H. M. Battle-ship Goliath. Sentinel (Westinghouse Type) Steam Engines. Marine Boiler Explo-

sions. Mechanical Ventilation for Steamships. Steam Engine Efficiency. The Steam Turbine for Warships. The Navy Estimates. Open Type High-speed Vertical Engine. Chertsey-built Steam Launches. The Operation of Water-tight Doors in Steamship Bulkheads. The Characteristics of Lighthouse Apparatus. Boilers for Steamships. Steam-driven Ammonia Compressor and Condenser. New System of Ship Propulsion. The U. S. Second-class Battle-ship Maine. Marine Boilers and Steam Pipes. The Edmiston Feed-water Filters.

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JUNE. Marine Boiler Explosions. The Babcock and Wilcox Water-tube Boiler. A Vessel for High Speed. Marine Engine Repairs. Care of Engines. Water-tube Boilers. Controlling Water-tight Doors. The Cost of Armor Plate. The Haythorn Tubulous Boiler for Passenger Steamers. The New Type of Armored Cruiser.

TRANSACTIONS OF THE INSTITUTION OF NAVAL ARCHITECTS, 1897.

Hardened Plates and Broken Projectiles. Non-flammable Wood. A Review of the History and Progress of Marine Engineering in the Royal Navy and Mercantile Marine from the Foundation of the Institution of Naval Architects to the Present Date. Water-tube Boilers in High-speed Ocean Steamers. On the Advances Made in the Mathematical Theory of Naval Architecture during the Existence of the Institution. Danish Steam Railway Ferries and Ice-breaking Steamers. On Graphic Aid in Approximating Hull Weights.

LE YACHT.

MARCH 5. High Power Explosives, and the Armor of Cruisers. Coast Defenses (continued).

MARCH 12. Coast Defenses (continued), Em. Duboc. Automatic Closing of Holes Caused by Shells.

MARCH 19. The Cup of France.

MARCH 26. Coast Defenses (Em. Duboc).

APRIL 2. Unquestionable Rights of Officers in the Navy. The Voyage of the Powerful from Portsmouth to Hong-Kong.

APRIL 9. The Navies of Spain and the United States (Em. Duboc). The Second-class French Cruiser Pascal.

APRIL 16. Specialization of Cruisers: Tactical Cruisers (Scouts), Despatch Cruisers, Destroyers, and Cruisers for Service in the Colonies.

The Boilers of the Battle-ship Pelayo.

The most important changes in the Pelayo while in the Seyne ship-yards were the replacing of the cylindrical boilers by the Niclausse boilers and, as a consequence, the modification of the ship's armament. As is already known, her primary battery consists of two 32-cm. and two 28-cm. in separate turrets; one turret forward, one aft, and one on each side. Three of the four pieces can fire at the same time. The secondary battery consists now of eleven Canet R. F. guns of 14 cm., ten of which are in protected redoubts, and one forward, as a bow chaser; formerly there was no protection for the guns. In spite of contrary rumors, the Pelayo is said to be in a satisfactory state of efficiency.

APRIL 23. Coaling Drills.

It is hardly necessary to demonstrate the importance of the question of rapidly refilling the empty bunkers of the ships of a squadron. In England, coaling ship has turned into a kind of sport, betting contests taking place between rival crews as to the number of tons each can stow aboard, say in an hour's time. The activity and endurance of the crews have been remarkable.

Deep-sea Torpedo-boats.

APRIL 30. The Hispano-American War (Em. Duboc). *La Jeanne d'Arc*.

An armored cruiser of 11,300 tons displacement. Total length, 145 m.; main breadth, 19 m. 40 cm.; draft aft, 8 m. 12 cm.; coal supply corresponding to the above draft, 1400 tons. The hull is partitioned in accordance with the most improved methods. The lower armored deck is on a level with the water-line, in the axis of the vessel; it descends 1 m. 50 cm. below the water-line, to the lower edge of the side armor. The latter is composed of two strakes, one whose upper edge rises 70 cm. above the water-line, and reaches down to the lower armored deck, and the other a thin strake.

MAY 7. The Hispano-American War. The Battle of Manila.

MAY 14. Submarine Lithologic Charts.

MAY 28. Military Power of Modern Fleets Compared with that of Ancient Fleets. The Fast Cruiser Chateaurenault of 8018 tons, built by the Forges et Chantiers de la Méditerranée.

REVUE DU CERCLE MILITAIRE.

MARCH 5. Cavalry Attacks in Battle against the various devices for supplying an Army Corps (2nd work on the chart), ended.

The Combat (Lieut.-Col. Paguin's Lecture) (continued).

MARCH 12. 19 Examinations for Admission to the "École Supérieure de Guerre." A Solution of the "Tactical Question." International Exhibition of the Army and Navy in 1900.

MARCH 26. The March, the Stand and Combat of Small Units.

APRIL 2-23. 3rd Work on the Chart, with Extra Map and Sketch.

MAY 7. The Moral Factor in the Command of Troops.

MAY 21. Psychology of the Battle-field.

MONITEUR DE LA FLOTTE.

MARCH 19. Increase of the English Navy.

MARCH 26. The German Naval "Sextennate" (1898-1903).

471,200,000 marks will be spent in installments, covering a period of six years, for new constructions.

APRIL 2. The Navy Estimates in the French Parliament.

APRIL 9. United States and Spain.

APRIL 23. The Proper Practice Ship for Midshipmen (French).

APRIL 30. Vessels Built on Speculation.

MAY 7. The Battle of Manila.

REVUE MARITIME.

FEBRUARY-MARCH. Solution of Some Kinematic Problems. The Right of Search in Time of Peace. The Current and the Exact Position of a Vessel with Land in Sight, and one Point only for a Bearing.

APRIL. An Essay on the Classification of Water-tube Marine Boilers.

RIVISTA DI ARTIGLIERIA E GENIO.

FEBRUARY. Questions Relative to the Organization of the Defenses of the Alpine Frontiers. A Study of a Permanent Battery (4 Plates). Field Redoubts and Defenses of Villages, Disguise System. Considerations and Propositions (3 Plates) Our Field Artillery on the Alpine Frontiers.

MARCH. On the Applications of the Principles of the Art of Defense.

APRIL. The Theorem of the Least Effort Applied to the Research of the Effects of Discharge of Fire-arms. Upon a Proposition to Modify the Use of the Coast Telemeter.

RIVISTA MARITTIMA.

MARCH. The Micro-organism of the Sea, and Alteration of Paint on Hulls. The English Army and Navy. Fourth Contribution to the Naval Kinematic.

APRIL-MAY. Sanitary Service in Naval Battles. About Actions Between Ships. The Spanish-American Conflict. Projections by Sections in Cartography.

REVISTA MARITIMA BRAZILEINA.

FEBRUARY. Proposed Regulations for the Naval School. Penetration of Projectiles through Resisting Mediums. Developments of the War Navies During the Last Decade.

MARCH. Penetration of Projectiles, etc. Project of an Airship. Developments of the War Navies, etc.

BOLETIN DEL CENTRO NAVAL.

DECEMBER, 1897. The Artillery of the Future. The Practice Ship Presidente Sarmiento.

JANUARY-FEBRUARY, 1898. The Part Played by the Gun in Naval Battles. The Next Naval War (ended). A Study of the Medical Service Afloat.

SOCIÉTÉ DES INGÉNIEURS CIVILS.

DECEMBER, 1897. Tunnelling by the Shields Process.

JANUARY, 1898. Some Results of the Trials of Marine Boilers.

Of all the steam generators, the writer gives the preference to the water-tube boilers, owing to the fact that the weight of the materials used is always much better utilized, and in most cases the consequences of an accident, which is always possible, are reduced to a minimum of seriousness.

A Note on Steam-emulsion Boilers.

FEBRUARY. Electric Heaters.

REVIEWERS AND TRANSLATORS.

Professor JULES LEROUX,

Lieut. GEO. F. COOPER, U. S. N.

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understood by common acceptance to mean the entire fleet of war vessels belonging to the state, together with all that pertains to their building, repairing, equipping, navigating and fighting.

The word fleet, from the Saxon *flot*, is used in England as synonymous with navy. Thus in the Articles of War of the British Navy, which date back to the time of the Restoration, it is declared by Art. 3rd that "if any officer, mariner or soldier, or other person of the fleet, shall give, hold or entertain intelligence to or with an enemy or rebel," etc. The same term is common to the French Navy: "Depuis peu," says Admiral Paris, "on a adopté les mots 'La Flotte' pour designer la totalité des batiments qui constituents l'effectif des forces navales disponible soit de paix soit de guerre du pays."

Writers in this country, however, especially those of the naval profession, are rather inclined to restrict the word fleet to its technical sense, and attach to it a definite meaning and one equivalent to the French *armée navale*, "an assemblage of at least twelve line-of-battle ships (*vaisseaux*) or ships of equal military value."

The history of navies reaches far back to the earliest known records. Passing thence to the prehistoric age, one may easily become bewildered in the misty sources of tradition. A sort of mirage pervades that distant horizon which strangely distorts the figures as they come in view. The earth and sky seemed blended in one, and the inhabitants of each meet, as it were, on common ground. It is as if the words of Moses that "the sons of God saw the daughters of men that they were fair; and they took them wives of all which they chose," found literal interpretation. Of such a nature is the story of Jason, who commanded the first naval expedition of which tradition speaks (1263 B. C.). Directed to seek the Golden Fleece in distant Colchis, in the Euxine, he ordered Argus to build a ship of fifty oars, which is named Argo after the constructor. Fifty of the most celebrated heroes of Greece join in the expedition and from the name of the ship are called Argonauts. Mopsus took auguries, and, when the omens were favorable the heroes embarked. Tiphys, to whom the invention of the rudder is attributed, was steersman. To the music of his voice Orpheus added the notes of his lyre, in unison with which the heroes kept time by the dip of the oar.

The voyage is replete with incident, and mortals and immortals associate on the most familiar terms. Among the heroes we find

the names of Castor and Pollux, brothers to that fair Helen whose beauty has been enbalm'd in deathless song. On the death of these youths they were placed in the constellation Gemini, and ever after had power over winds and waves. It was for this reason that they were regarded with reverential awe by the mariners of the East, who never failed to invoke their aid in the hour of danger. Their images were borne on some part of the ship or were painted on the side of the prow. That this beautiful tissue has been wrought upon a foundation of sober truth there can be no doubt; and it is curious to observe how one, at least, of the superstitions of the period, or rather the trace thereof, has been transmitted through all these ages even to our own times. After his shipwreck on the island of Melita (Malta) St. Paul departed in a ship of Alexandria, "whose sign was Castor and Pollux." It is this primitive custom of the seaman adorning the prow of his ship with the effigy of some favorite hero, whether of gods or of men, that has come down to the present day. The Goddess of Liberty is a favorite emblem for the figure-head of ships in our mercantile marine; the head of Philip, king of Macedon, carved in wood, graced in years gone by, the "prow" of the frigate *Macedonian*, and is still in excellent preservation at the Naval Academy; while the intellectual brow of Benjamin Franklin, in effigy, now forms the figure-head of what was, in her day, the finest ship of our navy. How the speculative mind of Lord Macaulay's New Zealander would regard these emblems should they be exhumed in his day, and how curiously the lives of the philosopher, the goddess, and the warrior may be blended in verse, must be left to the Homeric days of the future.

The next naval expedition worthy of note was that undertaken by all the great heroes of Greece (1193 B. C.) for the recovery of Helen, wife to Menelaus, who had been abducted by Paris, son of Priam, king of Troy. The fleet which bore the Grecian hosts to the Trojan shore is fully catalogued and partially described by Homer, and such is his fidelity to truth that he is often quoted by writers of antiquity as an authority for historical facts.

Great Agamemnon rules the numerous band.

High on the deck the King of Men appears
And his refulgent arms in triumph wears;
Proud of his host, unrivall'd in his reign,
In silent pomp he moves along the main.

The following portrait, drawn as it is by the hand of a master, will answer for any great leader of any age or clime, more particularly if we render it in a moral rather than in a physical sense.

The King of Kings, majestically tall,
Towers o'er his armies and outshines they all.

.
Great as the gods th' Exalted Chief was seen,
His strength like Neptune, and like Mars his mien.
Jove o'er his eyes celestial glories spread,
And dawning conquest played around his head.

The largest vessels of the fleet were those of Boeotia.—

Full fifty ships they send and each conveys
Twice sixty warriors through the foaming seas.

The smallest were those of the division commanded by Philoctetes.

Seven were his ships; each vessel fifty row.

These latter were known as pente-konters. The fleet numbered altogether twelve hundred vessels. They were so light as to be readily hauled up on the beach, generally stern first; were propelled by oars and, when the wind was favorable, by sails, and are frequently described as of a "sable hue."

"Who landed first lay highest on the shore."

That a punishment similar to "flogging through the fleet," at one time admitted by the severe discipline of the British Navy, was not unknown to the Greeks may be fairly inferred from the following: Thersites, "loquacious, loud and turbulent of tongue," for discoursing in a highly insubordinate strain of the commander-in-chief, is severely reproved by Ulysses:

With indignation sparkling in his eyes,
He views the wretch and sternly thus replies.

.
"Gods! let me perish on this hateful shore
And let these eyes behold my son no more;
If, on thy next offence, this hand forbear
To strip those arms thou ill deserv'st to wear;
Expel the council where our princes meet,
And send thee, scourg'd and howling through the fleet."

Helen, standing on the Trojan walls, names over to old Priam the heroes from beyond the Aegean Sea, as they are now seen

on the adjacent plain, and sadly bemoans the absence of her brothers, whose fate has been already told.

Yet two are wanting of the numerous train,
Whom long my eyes have sought, but sought in vain.

.
Perhaps the chiefs, from warlike toils at ease
For distant Troy refus'd to sail the seas;
Perhaps their sword some nobler quarrel draws,
Asham'd to combat in their sister's cause.
So spoke the fair, nor knew her brothers' doom,
Wrapt in the cold embraces of the tomb:
Adorn'd with honors in their native shore,
Silent they slept, and heard of wars no more.

Translated from an earthly grave, tradition tells of their glistering soon after from their bright spheres above, keeping their ceaseless vigils over the seaman in his perils by the sea.

But it is time to leave these scenes and speed our way down the course of time. The seamen of Gennesareth were blessed in seeing a brighter light than ever streamed from heavenly constellation. They were taught to invoke a stronger power than that of Castor and Pollux, and in their extremity to cry, and not in vain, "Save, Lord, or we perish!" Since that blessed day the mariner has, in deed and in truth, looked to Heaven to guide him on his way along the treacherous deep. And what navigator, so cold of heart, so undiscerning as to contemplate the "spangled heavens" and see, in fancy, that great system of spherics, on the correct solution of which his art and his safety alike depend, without a feeling of awe, mingled with admiration, for the grandeur of the design and the inconceivable wisdom of the Great Architect of all.

The history of navies, or of naval architecture, does not commonly go back to the Ark; and yet there is a curious fact to be noticed with regard to the dimensions of that structure as given by the Divine Architect. About 4000 years ago God said to Noah, "Make thee an ark of gopher* wood." "The length of the ark shall be three hundred cubits, the breadth of it fifty cubits and the height of it thirty cubits." † In terms of breadth

* Gopher wood, or cypress, a light and durable wood, and much used by the Phenicians for ship-building.

† Allowing 21 inches to the cubit gives: length, 525 feet; breadth, 87½ feet; depth, 52½ feet; and a little over 19,000 tons. The ark had three decks. She was not, in a modern sense, a ship, but rather an immense floating box with great capacity and stability.

this gives six times the breadth for the length, and six-tenths of the breadth for the depth. In the early part of the seventeenth century a Dutch merchant named Peter Jansen caused a vessel to be built on the same proportions. Though much laughed at by the community in which he lived, he found that his vessel would carry about one-third more than any other with which he could compare her, and yet employ no more hands. The best line-of-battle ships of the French at the beginning of the present century (the most scientific ship-builders of that day) did not quite reach four times their beam for their length. Our own *Ohio*, considered the finest line-of-battle ship of her day (1820), was 198 feet long, 50.4 feet beam and 40.6 feet deep, less than four breadths in length. The *Great Republic*,* however, one of the most perfect specimens of naval architecture of modern times, was 325 feet long, 53 feet beam and 39 feet deep. Allowing for overhang, etc., will bring the general proportions of this splendid ship very nearly to those of the ark and a little over one-fifth of the tonnage—proportions which have, only at this late day, become recognized as the best for wooden sailing ships.

It has been finely observed that on the shores of the Mediterranean were the four great empires of the world: the Assyrian, the Persian, the Grecian and the Roman. "All our religion, almost all our law, almost all our arts, almost all that sets us above savages, has come to us from the shores of the Mediterranean." It was on the eastern shores of that sea, too, that commerce and navigation took their rise and where navies had their birth. Ocean commerce and navigation are in a certain sense the parents of navies, and it will be found in the history of the world that where nations have cultivated and fostered the former, the latter have sprung into existence as a natural sequence, the one giving wealth and power to the possessor, the other position and influence. "Commerce follows the flag" may be more properly rendered, "The flag follows commerce."

About 1635 years B. C. the dying patriarch Jacob gathered for the last time his many sons about him. His bodily eye was dim with age, but with the unfading eye of faith he looked into the great womb of futurity and mingled prophesy with his last blessing: "Zebulon shall dwell at the haven of the sea; and he shall be for an haven of ships and his border shall be unto Sidon."

* Built by Mr. Donald McKay, of Boston, in 1853, for the California trade.

It was indeed from Phenicia, a narrow strip of land lying between the mountains of Lebanon and the sea, that the earlier mariners sprung. Rich in all the products favorable to maritime enterprise and bordering on a vast empire, Sidon, and afterwards Tyre, its principal ports, became the great commercial centres of the world. Stimulated by success, the Phenicians* pushed their enterprise westward, founding colonies and establishing trading posts wherever lured by the hope of gain. The inspired writers afford abundant evidence that they were not ignorant in those days of the value of foreign commerce. After telling of the great wealth of Solomon the sacred narrative continues: "It was nothing accounted of in the days of Solomon, for the King had at sea a navy of Tharshish with the navy of Hiram: once in three years came the navy of Tharshish, bringing gold and silver, ivory, apes and peacocks, so King Solomon exceeded all the kings of the earth for riches and for wisdom." The navies† of the two kings were united in distant voyages, partly to the western coast of the Mediterranean as far as Spain, vaguely described under the name of Tharshish, and partly from the two ports of the Red Sea to the shores of Arabia and possibly of India. The latter navy traded chiefly to Ophir. Again in Chronicles: "And Hiram sent him by the hands of his servants ships and servants that had knowledge of the sea: and they went with the servants of Solomon to Ophir and took thence four hundred and fifty talents of gold and brought them to King Solomon" (B. C. 1015 to 975). The prophet Ezekiel gives a glowing description of the wealth and importance of Tyre. The picture there drawn is heightened in effect by the lofty tone of the prophet enriched by the imagery of the eastern tongue: "O Tyrus that art situate at the entry of the sea, which art a merchant of the people of many isles. Thus saith the Lord God: 'Thy borders are in the midst of the sea, the builders have perfected thy beauty. They have made all thy ship boards of fir trees of Senir: they have taken cedars from Lebanon to make masts for thee. Of the oaks of Bashan have they made thine

* *Phenicians*, from the Celtic words *foene* and *oice*, i. e. "ploughers of the sea."—Jenks' Scripture Gazetteer. Plausible as this may appear, it is incorrect. The Celts knew nothing of the Phenicians in the Homeric times, and Homer uses the word. They were the people of the "purple age." See Athons Class. Dic.

† Not used in the sense now common, but rather to express a number of ships.

oars: the company of the Ashurites have made thy benches of ivory, brought out of the isles of Chittim.'” “Fine linen with brodered work from Egypt was that which thou spreadest forth to be thy sail: blue and purple * from the isles of Elishah was that which covered thee. The inhabitants of Zidon and Arvad were thy mariners: they, wise men, O Tyrus, that were in thee were thy pilots,” etc. It is from Sidon and Tyre—Tyre, the modern town of Soor or Sur, about thirty miles to north'ard of Acre in Palestine—that we trace, as from original sources, navigation, seamanship and all that pertains to the mariner's art. From Tyre the Phenicians established a colony at Carthage, which in its turn became the great commercial centre of the world, and in its day (B.C. 878 to 480) the greatest city of Africa and the rival of Rome itself. Still passing westward, navigation reached Cartagena and the Pillars of Hercules, great nations springing up in its course. Greece held her empire for a while to be succeeded by Imperial Rome. Venice from her dank marshes, her scattered isles and salt trade became mistress of the seas and monopolized the ocean trade, only to be disputed in time by the Genoese.

Passing thence to Portugal and Spain, to Holland and Britain, till finally, gathering strength and boldness, navigation shot out over the vast wilderness of unknown waters to find new shores for still greater empires: opening out new fields of commerce, discovering riches undreamed of by Avarice, effecting a revolution in navigation and in ship-building, and at one great stride bringing mankind to a degree of culture and refinement—a higher civilization, with all its attendant blessings, which could only have been anticipated by Prescience itself.

From that blessed night when, under the soft Syrian skies, the wondering shepherds heard angel voices heralding our Lord, no event has been so pregnant of results to the world's history as that which transpired at the little port of Palos in 1492. On the third day of August of that year the Santa Maria, bearing the flag of the High Admiral, Columbus, and leading the Pinta and Nina, sailed thence and marked a new era in the world's age. Thus the colony of the Phenicians in its turn sends out its navy to found new colonies. It is when taking this view of the tide of events that we are impressed with the truth and beauty of Bishop Berkely's celebrated line—

Westward the course of empire takes its way.

* Hence the name of Phenician from the Tyrrian or purple dye.

In this great onward march navies have been the untiring pioneers, showing that the paths of the seas have ever been the paths of human progress and civilization. As the discovery of new shores rewarded the adventurous boldness of the seaman, new colonies sprung up, and the same navies that had led to their foundation would be there to protect and foster their young energies—securing the merchant in the peaceful pursuit of legitimate trade and protecting his argosies from plunder on the seas. Such has been the grand rôle of navies. Such it continues to be. Well had it been for mankind, humanly speaking, could their sphere have been limited to the fields of peaceful commerce. The course of empire is unhappily marked by a trail of blood. Navies have, but too often, been prostituted to the uses of unscrupulous princes for the subjugation of weaker states; for the acquisition of wealth and territory by a species of national or state piracy, and not infrequently by even so-called Christian powers as the *ultimo ratio regum*.

The ocean commerce of the Phenicians constituted the great nursery of seamen, and led subsequently to the formation of the powerful navy of Carthage. Phenician seamen were employed as mercenaries and were to be found in no inconsiderable numbers in the Persian and other fleets. But there was another kind of pursuit which, while it gave rise to a race of bold and practised seamen, was itself the active and immediate cause of the establishment of navies. It was piracy.

The Aegean sea was ploughed by the piratical galley of many an isle; and many a Grecian chief owed his wealth to that source of livelihood. Menelaus, in the *Odyssey*, displays his treasures and boasts of the manner in which they were gained. Piracy, so far from being deemed dishonorable, was rather reckoned to one's credit. But to those who were not pirates this mode of acquiring property was, at the least, inconvenient. Thus Thucydides, in speaking of the earlier Greeks, remarks that "Minos, king of Crete, was the most ancient of all with whom we are acquainted by report, that acquired a navy and swept piracy from the sea, as much as he could, for the better coming in of his revenues."* The Cretan navy became formidable in

* Minos was a Phenician. He is recorded in history as having created a large naval power and of having established in Crete the most ancient recorded political system, calculated to combine the liberty of citizens with regular government; it was the model of Lycurgus' subsequent institutions for Sparta (*Jenks' Scripture Gazetteer*, p. 76). Minos, according to Thucydides, died about three generations before the Trojan war, or, according to modern historians, 1006 years before Christ.

its day, but having fulfilled its ends was subsequently overshadowed by the more powerful fleets of Athens and Peloponnesus.

Of other navies we have hints in the following: "The most ancient sea fight with which we are acquainted," writes Thucydides (B. C. 403), "was fought between the Corinthians* and the Corcyraeans." "For the Corinthians having their city situated on an isthmus had always possessed an emporium and obtained the title of 'wealthy,' and when the Greeks began to make more voyages, having got their ships, they put down piracy." "And the Ionians afterward had a large navy in the time of Cyrus, the first king of the Persians, and Cambyses his son; and while at war with Cyrus, commanded the sea along their coast for some time."

"Polycrates also, tyrant of Samos in the time of Cambyses, having a strong fleet, both made some other of the islands subject to him and took Rhenea and dedicated it to the Delian Apollo. And the Phoceans, while founding Massalia (Marseilles), conquered the Carthaginians in a sea-fight."

"These were the strongest of their navies and the last that are worth mentioning established in Greece before the expedition of Xerxes" (Thucydides).

This brings us down to the period of Greek civilization, when it had reached its highest level, and when the navies of Greece had attained their most thorough state of efficiency.

It will be our endeavor at some future time to give brief sketch of the Athenian navy, one of the most notable of all the navies of antiquity.

* The Corinthians were the first people of Greece who became a maritime power. Corcyra, from being a colony, became the rival of Corinth and so continued for about two centuries, till Athens joined Corcyra and assumed for herself the dominion of the seas.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SUBMARINE TELEGRAPH CABLES IN TIME OF WAR.

By Commander C. H. STOCKTON, U. S. N.

Though the recent hostilities with Spain were so short in duration, and so restricted as to opportunities for the settlement of important questions of war and international law, there was, nevertheless, one matter which assumed an importance throughout the entire period, and that was the question of international telegraphic communication by means of submarine cables in time of war.

From the time of the cutting of the Manila cable by Admiral Dewey, until the removal of the censorship of the communication by cable between Havana and Europe, it was a matter always under consideration by the belligerents, and far from being ignored by the neutrals concerned.

It was, of course, not entirely a novel question in the works and discussions upon international law, but it was a question which, though meagre as to usage, is constantly extending in its geographical area in the world as well as increasing in importance, both for peaceful and warlike purposes.

The general question of the international protection of submarine telegraph cables on the high seas and elsewhere led, in the past, to various general conferences upon the subject in Europe; the last one being held in Paris, at which was concluded a convention on March 14, 1884, the ratifications of the signatory powers being exchanged on April 1, 1885, and the date arranged for the agreement or convention to go into effect was May 1, 1888. To this convention the United States was a party, the Hon. L. P. Morton being our representative. The convention treated of the laying and protection of telegraphic cables in time of peace, Article XV of the convention reading as follows:

"It is understood that the stipulations of this convention shall in no wise affect the liberty of action of belligerents."

Concerning this article, Dr. Macdonell, an English lawyer of recognized standing, in a recent lecture, says:

"The 15th article of the Submarine Cable Convention expressly reserves the rights of belligerents, which, I take it, include cutting or injuring any cable likely to be useful to an adversary, however injurious such interruption may be to neutrals. This is confirmed by referring to the *procès verbal* of the proceedings. I find that the Belgian delegate, M. Orban, stated that 'as he read the article, the text recognized the liberty of action of the belligerent, and, by implication, his right to cut submarine cables, even those that land on neutral soil.' Another representative at the conference gave formal intimation, at an early stage in the proceedings, that the convention for the protection of submarine cables should have no application except in time of peace. At the time of signing the convention, Lord Lyons presented a declaration in the name of the English government to the following effect: 'Her Majesty's Government understand by Article 15 that in time of war a belligerent power which has signed the convention will be as free to act in regard to submarine cables as if the convention did not exist.' M. Orban, the Belgian delegate, added a declaration to the same effect: 'The Belgian Government, by the medium of its delegates at the conference, has maintained that the convention had no effect on the rights of belligerent powers; these rights would be neither more nor less extensive after the signing of the convention than before.'"

"There is little doubt that it was the opinion of the signatories of the convention of 1884 that a belligerent might freely cut submarine cables—might, for example, sever the connection between England and her colonies and foreign possessions without just cause of offence."

So far as the usage is concerned, up to the time of our war with Spain, it is confined, as far as I can ascertain, to the Franco-German war, the war between Chile and Peru, and the civil war in Chile. In these cases cables were cut both within the territorial waters of the belligerents and in ex-territorial waters or the high seas. The belligerent action of the late war in cable-cutting, which was wholly upon our part, did not limit the cutting, or the attempts to interrupt the communication, either to the territory or to the property of the belligerent concerned.

There can be little doubt as to the right of a belligerent to

cut, destroy or interfere with a submarine telegraph cable or terminal station, no matter by whom owned, in the territory, land or water of the enemy, whenever military necessity or convenience requires it. The belligerent concerned is the sole judge of this necessity and of the nature of the interference which he proposes to create. Such an act is, of course, a belligerent act, and neutrals participate in it at their risk, as when they enlist in a belligerent's army or navy.

It is generally recognized, certainly by the United States, that under certain circumstances and conditions, materials for the construction of telegraphs are contraband of war. Submarine cables, if found ashore in belligerent territory, or afloat, bound for a belligerent destination, as an enemy's port or fleet, would certainly be liable to seizure as material for the construction of a telegraphic communication, and hence contraband of war. If it then can be considered contraband of war on its way to a hostile destination on the high seas, as material or a component part only of a working telegraph, how much more does such a cable become contraband of war when it is in working order, actually conveying aid, information and, possibly, money to a belligerent or belligerent country in time of war.

Much could be and has been said about the commercial importance and general usefulness and harmlessness of telegraphic communication by cable to neutrals and to innocent persons of both belligerents in war time, but such usefulness must give way to the stern necessities of war. War, as our late hostilities prove, is not a benevolent measure, nor can it be successfully used as a means of immediately conveying benevolence or charity. That, ultimately, it may become of service in that direction there is, I think, but little doubt; but during the active operations, convenience and commerce must, when necessary, step aside. There is no doubt also, to take an instance, of the convenience and utility and even humanity of a system of buoyage and lights ashore and afloat for the purposes of navigation and safety; yet, in times of war, the extinction of sea-coast and harbor lights and the removal of buoys is directed by belligerents and submitted to by neutrals without question as matters of military necessity and right.

Besides the contraband character of the material of a telegraphic cable, in use or *en route*, as an essential element of belligerent communication which renders it liable to seizure anywhere out of neutral territory, there is another phase of this

question, and that is in regard to the nature of the service afforded by such a communication by a neutral proprietor to a belligerent.

This service is in the nature of both an evasion of a blockade, and, what has been termed of late years, of unneutral service. It does not matter in this phase whether the cable be privately or state-owned so far as the technical offence is concerned, though the gravity and consequences are naturally much more serious in the latter case. Let us take, as an instance, the case of a blockaded or besieged port, as Havana and Santiago were during the late hostilities. The communication of information, or of dispatches, or of means of assistance which can be made by such means, is an unneutral service, and would resemble also the violation of a blockade by a neutral vessel carrying dispatches, the capture of which upon the high seas outside of territorial jurisdiction would be a justifiable and indisputable act of war.

Extend this to a country or port not blockaded or besieged, and you would yet find the cable, owned, let us presume, by a neutral, the means of performing the most unneutral kind of service, of a nature which, done by a ship, would most properly cause its seizure, condemnation or destruction by the offended belligerent.

There are, however, other conditions existing besides that of a cable leading by way of, or from, a neutral country to that of a belligerent. Such is the case of a cable laid between two neutral ports, link of a chain, perhaps, reaching from a belligerent to his colony or foreign possessions. In this case there is little doubt but that the cable should be exempt from seizure or attack—the transit of continuous hostile or belligerent messages is too slight a matter compared with the gravity of interruption to allow such a cable to be tampered with. The Institute of International Law, in a session held in 1878, adopted the conclusion or declaration of opinion "that any submarine telegraphic cable that united two neutral territories should be held inviolable." This will doubtless be firmly established in time to come as a sound rule, as is both reasonable and proper.

If, however, there should be a neutral station or landing place interposed between the termini of a cable, both termini being on territory of the same belligerent, the safety and use of the cable could, perhaps, be assured by a censorship on the part of the neutral as to messages. A belligerent to whom such a cable is of essential military importance should provide for this contin-

gency by laying a cable or loop outside of the neutral territory, if the entire distance is not beyond the telegraphic range of the instruments. At all events, one belligerent is not unreasonable in demanding that the neutral should not permit messages from the other belligerent passing through neutral territory, of a nature injurious or disadvantageous to himself. It is not unlike the transit of troops through neutral territory; even if such be granted alike to both parties, it may still work injuriously to one of them. If, however, neither belligerent offered objection or if mutual consent was definitely given, permission to use the cable indiscriminately by both belligerents could be properly allowed by the neutral country or by the neutral cable company.

When possible cable communication generally should, of course, be kept open for commercial or other innocent intercourse, and in many cases a government censorship can meet the circumstances and requirements of the war and prevent injury to a belligerent. It is gratifying to know that to this solution of the question the practice of the United States in the late war greatly contributed.

In conclusion it may be interesting to state the circumstances at Manila, after the action of May 1st:

The cable from Manila to Hong Kong was owned and controlled by an association of English and Danish companies and subsidized by the Spanish government. After the battle of Manila Bay, Admiral Dewey asked for its use and agreed to its use also by the Spanish if he could send his dispatches. This the Governor-General of the Philippines refused, and hence Admiral Dewey cut the cable. The cable company refused to send Admiral Dewey's dispatches through Hong Kong, notwithstanding his offer to pick up the cable and provide the instrument for its use in Manila Bay.

In this case the right to cut the cable was undoubted. The common use of the cable by both Admiral Dewey and the Governor-General, if agreed upon by both parties, would have placed the cable in a neutral position—both parties agreeing. The use of the cable by Admiral Dewey alone, or by the Spanish alone, would have placed the cable company in the position of aiding one side at the possible expense of the other. The use of the cable at Hong Kong station was, in all probability, common to both sides, and without objection from either belligerent. The fact that the cable was subsidized by the Spanish government

made it more than ever a belligerent instrumentality, subject to seizure or disabling by the other belligerent, but doubtless also made the cable company feel that it would be especially unwise to lend aid against the subsidizing power.

Authorities.—Dr. Macdonnel, *Journal Royal United Service Institute*, No. 246, p. 916; Perels, *Manuel de Droit Maritime International*, pp. 75, 77, 217; Fiore, *Nouveau Droit Inter. Public*, p. 22; Owens' *Declaration of War*, pp. 182, 382; *Manual of International Law*, Ferguson, sections 123, 124; *Treaties and Conventions of the United States*, 1776 to 1887, pp. 1176, 1187.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By CHARLES MUNROE.

No. XXIX.

The "Twenty-first Annual Report of Her Majesty's Inspectors of Explosives" shows that the growth of the trade in explosives in Great Britain continues to increase notwithstanding the restrictions and governmental supervision imposed by the Explosives Act, five new factories having been licensed during the year and seven applications for licenses being still pending, while seven new magazines were licensed and nine others pending. The areas of the existing factories have also been enlarged so that, for instance, the site occupied by the Nobel's Explosive Co. Ltd., at Ardeer, is four times as large as it was when the Act was passed, while the number of buildings occupied by the company has increased in a similar proportion.

There was imported during the year—

Amorces	2,540 pounds.
Bellite	44,250 "
Blasting gelatine	27,500 "
Carbonite	579,000 "
Coopall's powder	3,950 "
Dahmenite A.	26,450 "
Dynamite	179,000 "
Emerald powder	5,000 "
Fulminate of mercury	9,400 "

* As it is proposed to continue these notes from time to time, authors, publishers and manufacturers will do the writer a favor by sending him copies of their papers, publications and trade circulars. Address, *Columbian University, Washington, D. C.*

Gun-cotton	56 pounds.
Gunpowder	66,528 "
Gelatine dynamite	416,650 "
Fireworks	556,920 "
Matagnite gelatine	57,050 "
Normal smokeless powder	178 "
Normal sporting powder	6,215 "
Pigou's smokeless sporting powder	1,000 "
Tonite	1,862 "
and 9,780,000 detonators.	

The total number of factories now in operation in Great Britain is 139, making 53 different kinds of explosive materials, yet but one person was killed during the year from an accident occurring during manufacture. The total list of accidents is as follows:

SUMMARY OF ACCIDENTS.

	Accidents causing loss of life and bodily injury.		Accidents not causing loss of life or bodily injury.	Total number of Accidents.
	No. of Accidents.	No. of Persons Killed. Injured.		
Manufacture	20	1 25	26	46
Keeping	6	6 4	3	9
Conveyance	1	— 2	1	2
Use and miscellaneous...	76	26 80	1	77
	—	— —	—	—
Total	103	33 111	31	134

Under use and miscellaneous are included all accidents which occurred in the use of explosives and immediately connected therewith; also accidents in thawing nitroglycerine preparations, and others arising from miscellaneous causes not within the prohibitions of the Act. In short, this group comprises all accidents occurring under circumstances not immediately controlled by the Act except the non-fatal, purely mining accidents with gunpowder under the Inspectors of Mines. It is natural to expect that the larger number of accidents will occur in use, as the explosives here get into the hands of many careless and untrained persons who are frequently free from supervision; yet numerous as the casualties for the year are, the number of killed was considerably below, and of wounded slightly below, the average for the preceding ten years.

As we have before remarked, these statistics would have greater value if accompanied by a statement of the amount of explosives produced and the amount of explosives consumed each year in the territory covered by the Act, and we are inclined to believe that if this were done the beneficent operation of the Act would be more strikingly shown.

An analysis is made of these casualty statistics on the basis of the number of factories in operation and persons employed, and it is pointed out that for the seven years immediately preceding the Act there was recorded an annual average of 39.5 deaths as based on the imperfect, non-compulsory returns from 55 factories only, whereas the average for the past ten years (there being now 139 factories and over 10,000 persons employed) the average for deaths is 5.1 (or about one-twentieth per cent. of the total number employed), and for injured 18.6 (or about one-fifth per cent. per annum). The saving in life is the more notable when it is recalled that a large proportion of the new factories established since the Act went into operation deal with entirely new classes of explosives and therefore with new forms of risks.

During the year the following substances were added to the list of authorized explosives: *Normal sporting powder*, consisting of nitro-cotton thoroughly purified, mixed or incorporated with potassium or barium nitrates or both of them, and paraffin or vaseline, both free from mineral acid, the whole gelatinized by a suitable process, grained and polished with or without graphite. *German spills*, consisting of cylindrical cases of paper, one-half charged with fuse composition, consisting of potassium nitrate, sulphur and charcoal, the other half containing a charge of gunpowder, the whole composition and gunpowder not to exceed two pounds to the gross, primed at one end with touch paper, and at the other with mealed gunpowder, or primed at both ends with mealed gunpowder. *Pettinger's electric fuses*, consisting of a cylinder of wood or other suitable material, containing two insulated copper wires, the ends of which, whether or not connected by means of a fine wire of platinum or other suitable material, are embedded in a priming composition, consisting of an intimate mixture of potassium chlorate, native antimony sulphide, copper subsulphide or subphosphide, silver (precipitated), plumbago, charcoal and bismuth. *Pettinger's electric detonator fuses*, consisting of Pettinger's electric fuses as above described and having attached thereto a detonator. *Kynite*, consisting of

not more than 27 parts by weight of thoroughly purified nitroglycerine (with or without the addition of not more than half a part of sulphuretted benzol), and with or without such other ingredient as may from time to time be sanctioned by a Secretary of State, uniformly mixed with not less than 75 parts by weight of a pulverized preparation, consisting of wood meal, not less than 40 parts, nitrates of potassium, barium, and sodium (or either of them), not more than 36 parts, and carbonate of sodium or calcium (or either of them), not more than half a part; such preparation to be sufficiently absorbed when mixed in the above proportions to prevent exudation of the nitroglycerine. *Oven blowers*, consisting of a short cylinder of paper dubbed at one end and charged with gunpowder, and having inserted in the other end a piece of quick-match encased in paper, projecting about four and one-half inches from the cylinder, the end of which is choked and tied, the projecting end of the quick-match being dubbed and coated with sulphur and the cylinder being afterwards flattened in a cracker mill.

Dr. Dupré's report is as usual full of interesting matter. It will be recalled that after investigation the amount of composition which was permitted in amorces was limited to .07 grains per amorce, it having been determined that this was a quantity which would prevent explosion *en masse*. An explosion which occurred at Kingston-upon-Hull in September in which several gross of boxes were destroyed gave rise to considerable apprehension in this regard. Fortunately a number of boxes from the same consignment and of the same manufacture were recovered from the shop after the explosion and examination showed that although the *average* proportion of explosive matter contained in the amorces was within the limit laid down, a not inconsiderable number of the individual amorces exceeded, and some very largely exceeded, this limit. Previous experiments had clearly established the fact that the safety of these amorces depends not so much on the average proportion of explosive matter contained in 1000 amorces as upon the fact that no individual amorce should exceed this proportion, since the larger amorce plays the part of a detonator, capable, if it contains too great a proportion of explosive matter, of exploding the whole, and this accident but confirms this deduction from the results of experiments.

Among the results of tests Dr. Dupré reports that 10 out of 113 samples of gelatine dynamite No. 2 and matagnite gelatine were rejected, four from failure to stand the heat test and six on account of exudation. The failure to stand the heat test may perhaps be due to the injurious effects exercised by some kinds of wood meal, but it is difficult to understand why, considering the absorbing power of the wood meal present in the gelatine dynamite, exudation should be more prevalent among samples of gelatine dynamite than among blasting gelatine.

The tests of five samples of American smokeless powder are recorded. "Four of the powders, American E. C., Hazard, Dupont, and Kings, closely resemble well-known English powders, consisting in greater part of nitro-cellulose, mainly of the soluble variety, with the addition of some nitrate of barium and potassium. The two first stood our heat test perfectly, and were well manufactured, the rest passed the heat test indifferently well, while the fourth stood the test for $6\frac{1}{2}$ minutes only.

"The so-called 'gold dust' differed, however, widely from any of our English powders; it consisted of picrate of ammonium, picrate of potassium, picric acid, and bichromate of ammonium. It was exceedingly violent in its action and appeared to be a rather dangerous powder to use in a shotgun."

The new explosives examined during the year were *bonnite*, which, like Kolf's powder, consisted of a mixture of different nitro-compounds, most of which are difficult to purify effectively. The first sample submitted was satisfactory as to its physical character and temperature of explosion, but it stood the heat test but two minutes on account of insufficient purification. The second sample passed the preliminary tests successfully, but lacked sufficient chemical stability to successfully resist prolonged exposure to 90° - 95° F., and it too was rejected. *Ripp-lene*, consisting of a nitrate mixture containing kerosene shale, was favorably reported on, subject only to the condition that the shale should be free from pyrites. *Patent blasting powder No. 1*, consisting of ordinary gunpowder mixed with a salt to prevent the production of flame on explosion, was also favorably reported on, as it possessed the required chemical stability.

Among the "Accidents" are two occurring in the manufacture of ballistite. In the first some sheets caught fire as they were passing through the rolls; in the second a small quantity exploded

in the press. The latter accidents have been thought due to the heat developed by the too sudden compression of the air in the interstices of the paste, but in this case the plunger was being withdrawn, and the accident is attributed to friction between the plunger and inside of the cylinder, where some accumulation of the paste is unavoidable.

The report on the fire occurring at the works of the Cotton Powder Co., Limited, near Faversham, on March 1st, develops the interesting fact that some 5000 to 6000 pounds of gun-cotton in water, which was exposed to the full effect of the fire, was practically uninjured, although in some cases the vats and vessels containing it were burnt away, and an even more important fact was the burning away inexplosively of over 3000 pounds of gun-cotton, containing about 30 per cent. of water, made for the War Office, and stored in barrels of $27\frac{3}{4}$ pounds each.

The most fruitful source of accidents in use has been during ramming, either from the use of improper tools or the application of undue force. As usual a preponderance of these accidents occurred in frosty weather when, owing doubtless to the explosive being hard, it is not so easily introduced into a rough or irregular hole, while the tendency to jam probably leads to an undue application of force. It is important to point out that in such circumstances even a wooden rammer is no protection, for more than half the rammer accidents were caused with wooden tools.

The accident at Kirkee, India, was of another sort. Two officers of the 28th Pioneers had cut some gun-cotton slabs into strips and dried them all day in the sun. One of the officers then attempted to ram these strips into a bore hole with a copper rod, when the charge exploded. No undue force appears to have been used and there is little doubt that the accident was due to the abnormal sensitiveness of the gun-cotton at the elevated temperature existing. The exceptional sensitiveness of nitro-cotton when heated, and especially when in a fine state of division, has been illustrated by more than one accident, and the circumstances of these accidents are fully dealt with in Special Report No. XLIV, of December 9, 1882.

The gravest accident recorded is that of the explosion of 55 "tons" of blasting gelatine at Braamfontein, near Johannesburg, South Africa, on February 19, 1896, in consequence of a rail-

way collision. The explosion produced a crater about 300 feet long by 65 wide and 30 deep in soft ground. There was total destruction within a radius of about 330 yards, while from that distance to 660 yards all the buildings were shattered, and roofs were battered in up to about 1000 yards. The buildings were chiefly of corrugated iron and mud, and therefore not of a substantial character. Fragments of iron were picked up at over 3000 yards. Windows were broken generally up to about 2000 yards, and in one direction, where the ground sloped toward the site, many windows were broken up to 5000 yards and some beyond that distance. These effects agree closely with those produced by the explosion of an almost equal amount of gunpowder at Erith in 1864, and the comparison is especially valuable, as in the "Table of Distances" used by the Inspectors in fixing the sites of factories and magazines the distances for 50 "tons" were derived from the data of the Erith explosion.

In another accident in South Africa at the Langlaate mine, Transvaal, a young man was so overcome by the poisonous fumes from the dynamite blasts in one of the levels, which filled the shaft, that he fell from the cage in the shaft on which he was standing and was killed.

An accident which appeals particularly to naval officers occurred in the magazine of the *Amiral Duperre*, flagship of the French Mediterranean Squadron, May 14, 1896, due to the explosion of a 34-centimeter cartridge in the midst of a lot of loaded shells, which fortunately remained intact. The explosion was attributed to the overheating of a steam-pipe passing through the magazine.

An explosion of ammonium nitrate at Paddington, March 20, and of bleaching powder, have especial interest to the chemist. In the first case the manufacturer was making "laughing gas" and had placed 18 pounds of ammonium nitrate in an open enameled iron pot on the furnace to melt when shortly the contents exploded, broke the pan and the iron plate of the furnace and blew down the brickwork. Although this property of ammonium nitrate has long been known* and was considered when the application of the Bellite Co. was before them, this is the first instance of such an accidental explosion brought to the notice of the Inspectors.

* Proc. U. S. Nav. Inst. 19, 92; 1892.

The explosion of bleaching powder, which was of a mild character, was reported to have occurred while a grocer was removing some bleaching powder from a barrel by means of an ordinary metal scoop. The bleaching powder, on examination, proved to be rather weak in chlorine, and contained nothing that seemed to throw any light on the nature of the alleged explosion. This is the second time an alleged explosion due to this cause has been brought to the attention of Dr. Dupré. We notice that "Bloxam's Chemistry," 7 ed., 162, 1890, speaks of bleaching as evolving oxygen so as to shatter the bottles, and heating up so as to set fire to the casks in which it is stored.

As usual there is a record of the big blasts of the year, the first being that at Bonawe Granite Quarries, Argyllshire, where 8 tons of gunpowder were fired. Six tons were placed in a chamber 125 feet from the surface and 65 feet from the face of the rock, and two tons in a second chamber 45 feet from the surface and 40 feet from the face of the rock, the distance between the two chambers being about 120 feet. The gunpowder used was especially manufactured for the purpose and contained 75 per cent. of saltpeter and was milled for three hours. The blast was estimated to have displaced 100,000 tons of rock.

The second blast took place at Dinorwic Quarries, Llanberis, and $3\frac{1}{2}$ tons of Nobel's gelatine were exploded, but no data as to the effect could be obtained.

A "petroleum accident" of special naval interest is one which occurred on board the Cunarder S. S. Servia when a party of men were engaged in painting the inside of a water-ballast tank. The tank, which was 3 feet 6 inches deep, was divided into 16 compartments with 18 inch aperture between each. The furthest compartment was being painted at the time and it was necessary to crawl through 15 of the small apertures to reach it. The paint used was styled Patent Bitumastic Solution and one of the survivors testified that it took him four to five minutes to reach the compartments, ten minutes to do the painting, and four or five minutes to return, and that he could not stoop down any longer as it made him dazed and queer in his head. All the witnesses testified that the use of the solution in confined spaces made them drunk and delirious if they remained any length of time at work. This is a well known effect of the lighter petroleums, and it is not surprising that the solution

was found to consist of coal tar dissolved in crude coal tar oil, having a flashing point of 45° F. Abel, and containing so much volatile matter that one gallon spread over a large surface would render 48 cubic feet of air inflammable.

Notwithstanding this the workman went into this inner compartment, which was already partly covered with the freshly-laid solution and containing a partly filled bucket of it, with a lighted candle. Sometime having passed without hearing from him another workman went to his assistance and found the place on fire and the man burned and delirious. He was so delirious as to fight against coming out and it took an hour and a half with assistance to get him through the apertures and up the manhole, and he afterwards died in the hospital from the effects of the disaster.

This report contains a copy of the Explosives in Coal Mines Order of 1896, a list of "permitted explosives" for use in coal mines, and much tabular matter of importance.

We have through these Notes repeatedly called attention to the dangers which accompany the use of explosives in coal mines, the results of experiments made by various commissions in France, Prussia and England, and the invention of various explosive materials especially intended for use in fiery mines. The more recent steps taken looking toward an increase in security in the working of these mines were, first, the Order in Council of the English Home Office of December 16, 1896, which prohibited the use of any explosive, other than a "permitted explosive," after July 1, 1897, in all coal mines in which inflammable gas has been found within the previous six months, or in the roads of all coal mines which are not naturally wet throughout, and after January 1, 1898, the use of any explosive other than a "permitted explosive" is absolutely prohibited in every part of such mines. Further, the use even of "permitted explosives" is prohibited unless (a) every charge is placed in a properly drilled shot hole and has sufficient stemming, not in any case less than 9 inches; (b) the apparatus or method used for igniting the charge shall be incapable of igniting inflammable gas or coal dust; (c) every charge shall be fired by a competent person appointed in writing for this duty by the manager of the mine,

and not being a contractor for any work in the mine involving the use of explosives, nor a person paid by such contractor, nor a person whose wages depend on the amount of material to be gotten; (d) each explosive shall be used in the manner and subject to the conditions prescribed in the schedule of "permitted explosives." The use of explosives is prohibited in any main haulage road or main intake unless all workmen have been removed from the seam in which the shot is to be fired and all seams communicating with the shaft on the same level, except the men engaged in firing the shot, and such other persons, not exceeding 10 in number, as are necessarily engaged in attending to the ventilating furnaces, steam boilers, engines, machinery, winding apparatus, signals or horses, or in inspecting the mine.

The Schedule of Permitted Explosives accompanying this order consists of ammonite, Ardeer powder, bellite No. 1 and No. 3, carbonite, dahmenite A, electronite No. 2, kynite, roburite No. 3, and westfalite. The composition of each and the method in which they are to be put up is given with great precision and, what is of particular interest, the strength of the detonator to be used is specified for each explosive. In the case of each nitro-glycerine explosive it is especially prohibited to fire it when in the frozen condition.

To secure more certain results a "Committee to inquire into the History of Explosives for Use in Coal Mines" was appointed by the Secretary of State, and through the courtesy of one of its members, Captain J. H. Thomson, R. A., we are in receipt of the "Report" * of this committee.

In its preliminary report of February 4, 1897, the committee considered the possibility of conducting its experiments in a coal mine, but concluded it would be fairer to use chambers where the conditions and tests could be made as uniform as possible; also the desirability of a small apparatus, but concluded that in view of the peculiar character of gas explosions no results would be trustworthy unless made in a chamber of considerable capacity and so arranged as to admit of experiments with air, gas and coal dust.

The committee then presented drawings of a suitable station to be erected at Woolwich and recommended an appropriation

* Eyre & Spottiswoode, London, 1897, 12 pp., 2 plates.

of \$7500 for its erection and proof. The full report of October 6, 1897, contains a description with drawings of the apparatus, which consists of (1) a horizontal gallery of wrought-iron tubing used to test the liability of an explosive to ignite mixtures of coal-gas and air, and (2) a vertical tube to test the effect on coal dust suspended in air.

The gas gallery is fitted at its outer end with a device for holding a diaphragm of varnished paper or other suitable material, and at the opposite end it is closed by a disc of wrought iron having an opening in the center which is closed by the muzzle of a cannon when the latter is run up into position. The cannon is a very strong steel-lined wire-wound gun, having a bore of a diameter about that of the usual bore hole, and it is mounted on a small trolley running on rails. To prevent accidents from the bursting of the cannon a concrete wall has been provided on the side on which the observers stand. The gallery is fitted with seven safety valves to remove the strain when the gas explodes, and these serve also as sight holes by which to observe any flame which may issue. As mere observation of this kind is somewhat untrustworthy, a tuft of gun-cotton yarn is used as an additional test of ignition and is securely fastened in a position at the end of the tube, where only an explosion of the gas can ignite it. Alongside the gallery is a gasometer fitted with a gauge showing its contents, and a centrifugal blower, which are connected by pipes with both ends of the gallery so that a circulation of air and gas can be maintained through the gallery, gasometer and fan.

In preparing to fire a charge in this portion of the apparatus, the cannon is loaded and run up to the gas gallery, the gasometer filled with a measured quantity of gas at atmospheric pressure, and then, by opening the valves with which the connecting pipes are fitted and starting the fan, this gas is driven into the gallery and air removed at the same time from the opposite end. By keeping up this circulation for about one minute a uniform mixture of gas and air is obtained with very little leakage. The valves are then closed and the charge fired, the results being ascertained in the manner indicated above.

The coal dust apparatus consists of a vertical tube resting on a bed of concrete, in the center of which another cannon is placed vertically, being fixed in position by slats of wood. The tube

is fitted, near its base, with an opening in its side, closed by a strong door, through which the loading of the cannon is effected, and also, near the top, with an air and observation hole. Into this tube coal dust is blown by a fan similar to the one referred to above, the dust being fed into the pipe by means of a hopper.

In operating this apparatus air is driven along the pipe past the hopper, from which it carries with it the necessary supply of coal dust, and so soon as the operator considers that sufficient coal dust has been blown into the tube the charge is fired.

The testing station consists of two buildings, one of which contains the gas gallery and fittings. This building is completely open on one side, and the second building, placed on this side of the first, is fitted with an observation slit for the use of those attending the experiments, and is also fitted up as an office and storehouse.

The conditions prescribed for making the test are: (1) No explosive shall be submitted for testing until it has been admitted to the Home Office List of Authorized Explosives; (2) the test will be carried out for each explosive with the size of detonator recommended by the manufacturer or person submitting the explosive, and every shot will be fired by electricity; (3) all charges to be stemmed with nine inches of clay well rammed; (4) each shot to be fired in the case or wrapper in which it is proposed to be employed in actual use; (5) each shot to be fired into a highly explosive mixture of coal-gas and air, the gas being supplied from the Royal Arsenal gas works; (6) the charges of explosives to be fired will be determined as follows: (a) in the case of explosives intended to be fired by a detonator, and commonly called "high explosives," the charge will be taken as the equivalent of 2 oz. of dynamite No. 1, containing 75 per cent. of nitroglycerine, as determined by the enlargement obtained on firing the same in a lead cylinder tamped with loose sand; (b) in the case of gunpowder or any explosive not intended to be fired by a detonator, the charge will be taken as the equivalent of 6 ozs. of R. F. G. gunpowder, as determined by the enlargement obtained on firing the same in a lead cylinder tamped with loose sand and heavily weighted above with a mass of metal. (7) Each explosive to be subject to the following test: A number of shots shall be tried not exceeding 40. If in the first 20 no failure occurs, or in the first 30 only one failure, or in 40 only two failures,

it will be passed. A shot will be regarded as a failure if (a) it ignites the gaseous mixture, or (b) it leaves an appreciable amount of the charge unexploded. A shot may be repeated at the discretion of the officer in charge of the testing, if in his opinion there is reasonable ground to believe that a failure was due to any cause unconnected with the explosive. The proposed fee for an original test is £25, for a second trial £15, and for retesting from time to time, not to exceed 10 shots, £2. Since June 5, when the apparatus was first tried in the presence of members of the Institution of Mining Engineers, upwards of 700 shots have been fired and in no case has any accident occurred to the apparatus, although the cannon have been subjected to pressures estimated at over 100 tons to the square inch. Owing, however, to the high temperatures and pressures at the time of firing the erosion of the hardened steel lining tubes has been so great that it has been necessary to insert a fresh liner after about 200 shots.

The report discusses in detail the use of coal-gas versus fire damp, uniformity of gaseous mixtures, method of electric firing, method of determining an explosion, nature and quality of stemming, usefulness of firing unstemmed shots, size of charge, method of determining comparative power of explosives, size of detonator, delayed ignitions and other important matters.

It may not be amiss to inquire how the system of determining rejections was arrived at, for it is not apparent in what respect an explosive which fails once in the third ten rounds or twice in the second twenty is better than one that fails once in the first ten rounds or twice in the first twenty, or even better than one which fails twice in the first ten rounds. Of course the assumption probably is that a failure in the first ten or twenty rounds indicates a possibility of failure later on, but this is by no means certain to follow. In fact, the more often a given explosive is fired under similar conditions the more certain ought the firing to be with the increased experience, and it seems fairer after the fee is paid to give the applicant his full forty rounds.

The explosive art and science have suffered a severe loss in the death of Colonel Sir Vivian D. Majendie, R. A., K. C. B., Her Majesty's Chief Inspector of Explosives, which occurred suddenly, from heart failure, at Oxford, England, on April 24, 1898.

Sir Vivian Majendie was born in 1836 and entered the Royal

Artillery in 1854. He first saw active service in the Crimean War, in which he won the medal, with clasps, and the Turkish medal, and he achieved further distinction in the Indian mutiny. He became Captain of Artillery in 1861, Major in 1872, and Lieutenant Colonel in 1880, and Colonel (retired) in 1882. He was created Commander of Bath in 1880 and Knight Commander in 1895. He was for ten years on duty at the Woolwich Arsenal and in 1871 was attached to the Home Office as Inspector of Gunpowder Works under the Gunpowder and Nitroglycerine Acts. He was largely instrumental in securing the passage of the Explosive Act of 1875, as his testimony in the Minutes of Evidence and the official and statistical papers he filed, which appear in the Appendix, fill 162 of the large, closely printed pages of the Report of the Select Committee on Explosive Substances appointed by the House of Commons. It was fitting then that after having had so wide an experience and having displayed such thorough acquaintance with the subject, Major Majendie should, on the passage of the Act, have been appointed Chief Inspector.

While holding this office it fell to his lot to examine the bombs, infernal machines and explosives captured by the police, and though he ran serious personal risk, he was fearless in the performance of his duty. It is narrated that on one occasion he carried a rubber bag filled with nitroglycerine, which had been found in the house of a Fenian, in a cab to the laboratory at Woolwich, and that on the way he coolly informed the driver of the danger the latter would run if he did not drive carefully. When the cloak-room at Victoria Station was blown up he opened a clock-work infernal machine found there, though the mechanism was working at the time and the machine might have exploded at any moment.

While his services in the investigation of outrages brought him most conspicuously before the public, his most important service to his country was in so drawing and enforcing the regulations in explosive works as to render employment in these factories among the less hazardous of occupations for British workmen. One of his recent official duties was as a member of the Committee on the Testing of Explosives for Use in Coal Mines, through which it was sought to reduce the hazard in use as well as manufacture, and the week before his death he appeared to give evidence before the Select Committee of the

House of Commons to investigate the danger of low-flash oils. His influence has extended far beyond the confines of his country. For his successful efforts to ameliorate the condition of man he deserves to rank with Davy, Jenner, Francis, Lister and Florence Nightingale. His monument is the twenty-two Annual and fifty Special Reports which bear his signature as Her Majesty's Chief Inspector of Explosives.

His efficiency and tactfulness as an official is testified to by the trade journal, "Arms and Explosives," 6, 126; 1898, which says: "The daily newspapers say nothing of the single-minded thoroughness with which he carried on the daily routine of his work at the Home Office, dealing only, as they do, with the more sensational incidents of his career, when, for instance, at considerable risk to himself, he opened an infernal machine, which, for all he knew, might go off at any moment.

"To those in the explosive trade, however, his ceaseless activity in the duties of inspection, the courtesy and fair-mindedness with which he carried out the stringent provisions of a highly complicated Act, will always remain among the keenest recollections of the past. Sir Vivian Majendie was the very best type of Government official, for he at all times recognized that trade interests must be considered even when departmental authority gave him the best excuse for disregarding such requirements. In no case, however, was the efficiency of his work allowed to suffer, whatever personal sympathies might suggest. He became Chief Inspector of Explosives when the Act first came into existence, and he has continued in office ever since, and year by year his annual reports have shown a steady improvement in the conditions of what was originally a dangerous industry. The precautions which have been elaborated under his care are now such that the death-rate by accident in the entire trade is little more than eight a year, a proportion which will compare most favorably with the ordinary mechanical industries of the country. To judge by experience, one would say that Sir Vivian Majendie was never happier than when carrying on his work, for the indefatigable industry with which he replied to all correspondence, and held himself personally available wherever his presence would be advantageous, was a lesson such as many younger men could with advantage take to heart. Whenever he was approached with a view to the modification of such rules and regu-

lations as seemed to bear with unnecessary hardness upon some section of the trade, he was always ready to receive representations upon the subject, and, wherever possible, he promptly introduced an Order in Council for remedying the ills which had grown up under changing conditions of trade."

The notice alludes to his fondness for photography and his love for children, which was heartily reciprocated by them, and it is accompanied by an admirable portrait which depicts the alert and ever-ready look which was the most prominent characteristic of the original.

The following specifications for smokeless powders for cannon, prescribed by the Ordnance Department, U. S. Army, were issued by the War Department May 12, 1898:

Manufacture.—The manufacture must be open to inspection in all its stages by an inspector designated by the Chief of Ordnance, U. S. A., for the purpose.

Composition.—The powder must be substantially of the composition designated by the Ordnance Department as N N (12.0-25), which consists of one part of nitroglycerine and three parts of nitro-cellulose, containing 12 per cent. of nitrogen, and at least one-third of the nitro-cellulose must be of the soluble variety. A small amount of a suitable neutralizer may be added to insure chemical stability. No departure from the above-stated composition will be made without the approval of the inspector. The ingredients must be of excellent quality and the degree of nitration, as determined by the Lunge nitrometer, close to that prescribed.

Granulation.—The granulation may be of any well-known form, suitable for the use intended, that may be desired by the manufacturer, but must be subject to the approval of the inspector.

Lots.—The powder will be prepared for inspection and delivery in lots, each containing, if practicable, about 10,000 pounds if for a piece of caliber below 8 inches, and about 25,000 pounds if for a piece of 8-inch caliber or over. The exact amount of each lot will be fixed by the inspector after consultation with the contractor. Each lot must be blended to the satisfaction of the inspector.

Inspection.—The inspector will select during manufacture such samples of the ingredients as he may desire to examine. After the lot is blended he will select samples for inspection and proof.

Proof.—Each lot, to be acceptable, must give, with about the charge and under the conditions stated in the following table for the particular case, a muzzle velocity as great as, and a mean pressure not greater than, therein stated, and the chamber pressure must not exceed in any round the pressure stated by more than 2000 pounds.

Piece.	Charge.	Projectile.	Chamber pressure.	Muzzle velocity.
		<i>lbs.</i>	<i>lbs. per sq. in.</i>	<i>f. s.</i>
{ .30-caliber rifle, service.....	37 grs.	.....	38,000	2,000
{ 3.6-inch mortar, service.....	6 ozs.	20	17,000	700
{ 3.2-inch field gun *.....	15.25 ozs.	16.5	32,000	1,450
{ 3.2-inch field gun †.....	16.6 ozs.	16.5	26,000	1,450
7-inch siege mortar, service.....	38 ozs.	125	17,000	775
8-inch B. L. rifle, service.....	70 lbs.	300	35,000	2,250
10-inch B. L. rifle, service.....	140 lbs.	575	35,000	2,250
12-inch B. L. rifle, service.....	250 lbs.	1,000	35,000	2,250
12-inch mortar, steel, service.....	50 lbs.	800	33,000	1,300

* With projectile having band $1\frac{3}{4}$ inches from base.

† With projectile having band $\frac{1}{2}$ inch from base.

NOTE.—For pieces within a bracket the same powder is used.

Stability.—The powder must not be unduly subject to accidental ignition or explosion, or to deterioration under exposure to climatic conditions or in storage. Also, it must withstand successfully the following test: Heated to a temperature of 150° to 155° F., it must not produce any discoloration of potassium iodide starch paper, partly moistened with dilute glycerin, in less than 20 minutes. Chemical and ballistic tests made by the Ordnance Department according to its standard methods will be regarded as standard for the purposes of these specifications.

Delivery and Payment.—The powder will be delivered packed in simple wooden boxes or in packages furnished by the Ordnance Department, at the option of the Chief of Ordnance. All samples selected by the inspector will be delivered at such places as he may designate by the contractor. Payment for each lot will be made on acceptance and delivery, but samples representing rejected lots will not be paid for.

The "Annual Report of the Chief of Ordnance War Department for 1897"* is made up of a summary by the chief of the operations of the department, and twenty-nine separate, illustrated

* Washington, Gov't Printing Office, 1897, 300 pp., 19 plates.

reports from the commanding officers of the various arsenals and the inspectors of powder and ordnance, which contain much detailed information and record the results of many interesting experiments.

Referring to small-arm ammunition and smokeless powder, General Flagler says the .30-caliber ball ammunition with strengthened case and the blank cartridge with paper bullet have given satisfactory results in service. The expectation that the fired .30-caliber shells turned in from service could be used for reloading has not been realized, as the metal of the case after being fired with smokeless powder becomes brittle. The cause of this in the present shell, which is made of brass (70 copper and 30 zinc), has been traced to the action of the mercury in the primer composition on the metal of the case and particularly on the zinc. The loaded cartridges, when new, can be safely kept as no deterioration occurs until after firing, when the primer is burned and the gases liberated within the case. At present it is expected that a serviceable reloading cartridge will be produced by reducing the amount of mercuric fulminate in the primer, in conjunction, possibly, with the use of an alloy for the cases containing a less percentage of zinc.

Another form of reloading case was proposed by Lieutenant Dunn, the feature of the design being a sliding base sealed with a rubber ring. It is in some respects similar to the Morse cartridge, but differs from it in essential particulars. It offers the advantage of using an alloy, such as so-called gilding metal (93 copper, 7 zinc), which is but little susceptible to the brittleness referred to, but which when made into the present form of solid head case does not possess sufficient strength to resist the high pressures attained in the .30-caliber rifle. The tests thus far made on this case for endurance are favorable and they are now being subjected to storage tests.

Investigations have been made upon the utility of tinning the case of the .30-caliber cartridge for smokeless powder, and the conclusions reached are that under normal conditions of storage brass cartridges do not need protection against erosive action from either black or smokeless powder, but when moisture is present in excess or when the powder has suffered material decomposition, a slight protection, serving at least to defer such action, is afforded by the tin coating, and this, taken in connec-

tion with the neat and distinctive appearance given to the finished product, justifies the use of tinning.

It has been observed that there is a marked tendency to rise and fall of velocity of smokeless powder ammunition depending upon the temperature of the cartridge when fired in the arm, and experiments have been made with the .30-caliber rifle cartridges to determine the changes in velocity for temperatures ranging from -40° to $+130^{\circ}$ F. at intervals of 10 degrees. For this purpose each lot of cartridges was brought to the desired temperature by exposure for twenty-four hours in a chamber having the required temperature and fired. From the data derived from these experiments and from repeated "heat" and "cold" tests previously made in the laboratory of Frankford Arsenal the average results deduced for service ammunition are as follows: The velocity for the .30-caliber rifle varies about 120 feet per second between the limits of temperature given. Taking the standard of 2000 feet per second for a temperature of 70° F. at proof, it diminishes for each 10° fall of temperature by decrements varying from 8 to 3 feet per second, the loss at -40° being about 43 f. s.; and for each 10° rise of temperature it increases from the standard by increments of from 10 to 12 feet per second, the gain at 130° being about 65 f. s.

The Peyton powder at present manufactured by the California Powder Works and the Dupont Company, is now used for the .30-caliber service ammunition, and is satisfactory. In addition to the contracts made with these companies for the supply of powder during the current year, a contract has been made with the Laflin & Rand Powder Company for a quantity to be delivered subject to test, and this company is now experimenting to produce a .30-caliber powder along the lines of its W-A powders. In previous tests this powder has shown excellent ballistic results, but produced undue erosion of the bore of the rifle. It has been found that the endurance of a rifle firing the Peyton powder will readily exceed 5000 rounds, and the specifications for the .30-caliber powder now include a test for erosion, under which "the erosion of the bore, after firing 5000 rounds, must not materially exceed that exhibited by the rifle barrel No. 21,244, which has been fired 5000 rounds and will be retained at Frankford Arsenal as a present standard of reference." It is now also provided that each invoice lot of powder must be thoroughly blended by the manufacturer.

The exposure of service cartridges in shallow open trays to the weather for one year is now systematically pursued and constitutes a most severe test of their keeping qualities. Lots of cartridges made from different invoices of powder are taken from the factory and exposed in this manner, and a portion of each lot is tested at the end of each four months. The tests made with the service powders during the past year confirm those previously reported. Although the loss of velocity from the exposed cartridges was sometimes considerable, the stability of the powder was not decreased, and when heated to 130° F. for twenty-four hours, to ascertain if the powder had been permanently injured, its ballistic properties were restored to nearly the same magnitude as those possessed by the original powder heated to the same extent. The interior of the cases was not injured by contact with the powder during exposure and the primers of the cartridges remained unaffected. Two additional lots of the .30-caliber cartridges charged with Peyton powder and sent to Whipple Barracks, Arizona, for storage, in April, 1895, were returned to Frankford Arsenal after storage periods of twenty-one and twenty-four months. When fired, these gave nearly the same results as those which had been stored for periods of three, six and nine months; in none of which was there any material change from the original quality of the ammunition.

Referring to larger grained powder, General Flagler says it appears conclusive that when nitroglycerine is used under service conditions there appears to be no objection to its employment in powder, but that, on the other hand, there are decided advantages on the score of high ballistics and economy. These conclusions are drawn from general information and from the results of experiments with various smokeless powder compositions, described in his last annual report as being in progress. All these, except those involving long storage, were completed during the year, and the results but confirm the conclusions derived from the earlier and principal portion of the experimental series.

To investigate more fully powders composed essentially of nitro-cellulose and nitroglycerine three compositions of the type designated "N N" (nitro-cellulose, nitroglycerine) were selected as follows:

N N (13-10); nitro-cellulose yielding 13 per cent. of nitrogen, the powder containing 10 per cent. of nitroglycerine.

N N (12-25); nitro-cellulose yielding 12 per cent. of nitrogen, the powder containing 25 per cent. of nitroglycerine.

N N (11-40); nitro-cellulose yielding 11 per cent. of nitrogen, the powder containing 40 per cent. of nitroglycerine.

These compositions were regarded as including the practicable variations within the type, and as producing only allowable erosion and heating effects. As granulation is a mechanical process it was thought best to interest private manufacturers in the solution of this problem, and contracts were therefore awarded to different firms under the above specifications but leaving the manufacturer to choose his form of granulation, it being expected thus to obtain comparisons of the behavior of these different compositions in the several forms of granulation, such as strips, thin squares, tubes and multiperforated grains. Other types than the "N N" are also to be tested and orders have been laid for sample lots of Peyton and "W-A" composition for the 8-inch B. L. R. and of Roltweil composition for the 10-inch B. L. R.

On August 2, 1898, the Navy Department issued the following specifications for U. S. Navy smokeless powder, which is an ether-alcohol colloid of soluble nitro-cellulose, with or without metallic nitrates. The specifications for the ingredients and the solvent are as follows:

I.—INGREDIENTS.

1. *Soluble nitro-cellulose, known as pyro-cellulose.*—It shall contain 12.5 ± 0.1 per cent. of nitrogen, at least 98 per cent. of soluble nitro-cellulose, and less than 1 per cent. of ash, cellulose, and other substances insoluble in acetone. It shall give a heat test at 65.5° C. of at least eighteen minutes, and shall be pulped very fine, all passing a sieve of No. 16 mesh.

2. *Barium nitrate.*—To be entirely free from moisture, ground very fine, all passing a sieve of No. 50 mesh, containing at least 99 per cent. $\text{Ba}(\text{NO}_3)_2$, less than 0.2 per cent. of chlorides (calculated as BaCl_2), and not more than 0.1 per cent. of insoluble material.

3. *Graphite*.—To be chemically pure, containing not more than a trace of silicates or compounds of sulphur.

4. *Potassium nitrate, c.p.*—To be ground very fine and thoroughly dry, of the quality employed in the manufacture of highest grade black powder.

II.—SOLVENT.

1. *Ethyl ether*.—Concentrated, containing no impurities except small amounts of water and ethyl alcohol; clear and colorless; of characteristic pure odor; neutral reaction; specific gravity at 20° C. between 0.717 and 0.723; leaving less than 0.002 per cent. residue after evaporation at 100° C.

2. *Ethyl alcohol*.—92.3 per cent. absolute (by weight). To be clear and colorless; of characteristic pure odor; neutral reaction; leaving less than 0.006 per cent. residue after evaporation at 100° C.

3. *Quantity*.—In case the mixed solvent, composed of 64 parts by weight of ether and 36 parts of alcohol, is supplied by the Department, the weight allowed will be equal to 1.1 that of the finished powder less that of the contained metallic nitrates, and in case alcohol only is furnished by the Department, the manufacturer making his own ether, the weight of alcohol allowed will be 1.4 times that of the finished powder less the contained nitrates.

III.—METHOD OF MANUFACTURE.

1. *Pyro-cellulose*.—No particular method of manufacture is prescribed, provided a material is obtained which conforms strictly to the above specifications. The following method has given satisfactory results at the torpedo station:

Cotton, free from oil and mechanical impurities and containing not over 7 per cent. of moisture, is dipped, in portions of 1 pound each, in 19 pounds of mixed acid contained in an earthenware crock. This mixed acid is composed of about 57 per cent. H_2SO_4 , 28.2 per cent. HNO_3 , and not more than 0.2 per cent. N_2O_4 . The initial temperature of the acid at the time of dipping is about 25° C. The cotton is completely immersed in the acid and held down by an earthenware disk. The crock with its contents is then placed in a trough of warm water, of which the temperature is

about 36° C. At the end of thirty minutes' digestion, the crock is removed from the trough, and the contents turned over with a fork. The crock is replaced in the trough and the digestion is continued for thirty minutes longer. The excess of acid is then removed in a centrifugal wringer and the pyro-cellulose is immersed in a large volume of running water. It is then transferred to a washing centrifugal wringer, where it is washed for fifteen minutes by a stream of water from a hose, being turned over at the end of half this period in order to facilitate the washing. The pyro-cellulose is next pulped at atmospheric temperature in a dilute solution of sodium carbonate, until the requisite fineness is obtained, and is then heated at 70° F. for three hours in a 0.05 per cent. solution of sodium carbonate and washed for three minutes in a centrifugal wringer.

2. *Smokeless powder*.—The finished pyro-cellulose, before the colloidizing, is to be dried or dehydrated until it contains less than 1.5 per cent. of water. The dry ingredients of the powder, consisting either of pyro-cellulose alone, or of pyro-cellulose and a prescribed amount of barium nitrate and potassium nitrate in the proportion of four parts of the former to one of the latter, are to be colloidized by means of a solvent composed of 64 parts by weight of ethyl ether and 36 parts of ethyl alcohol, the weight of solvent being at least equal to that of the dry pyro-cellulose. The mixing is to be continued until the material is a perfectly homogeneous mass, free from uncolloidized particles. No change in the composition of the solvent or in the ratio of solvent to dry ingredients is to be allowed, unless the product is a perfect colloid of standard toughness. This colloid is to be pressed into powder through dies of such form and dimensions as may be prescribed by the Department for the different calibers. In case the powder is in the form of a ribbon, the drying is to take place between wooden strips, or sheets of blotting paper, or in such other manner as will prevent warping or sufficient distortion to render difficult the loading of the powder into the cartridge case. In the manufacture of small-arm powder, the colloid, in the form of a sheet, is to be cut into flat grains, nearly square in outline, of which the length or width is to be about 2 mm. and the thickness about 0.28 mm. After not less than twenty-four hours' drying, these grains are to be graphited. The finished powder for all calibers shall have been dried at 38° to 43° C. until a sample, heated at

100° C., loses less than 3 per cent. of its weight before an odor of decomposition is noted.

IV.—FINISHED POWDER.

1. *Physical properties.*—(a) The finished powder is to be a perfectly uniform colloid, free from lumps and uncolloided material.

(b) The strips or grains are to be of the standard smoothness and toughness.

(c) The dimensions of the strips or grains are to be in accordance with the specifications of the Department.

(d) The strips or grains shall be of such uniform density that, in a given weight of charge for any caliber, the variation from a mean value in the number of strips or grains shall not exceed 1 per cent.

2. *Chemical properties.*—(a) *Composition.*—The finished powder shall contain not more than 3 per cent. of substances volatile at 100° C., and shall show, by analysis, that its ingredients possessed the requisite properties and were mixed in the prescribed proportions.

(b) *Stability test.*—The finished powder should give a stability or heat test equal to that of similar powder made at the torpedo station, which withstands a temperature of 100° C. for a period of at least ten minutes without discoloring the standard potassium iodide and starch paper.

This test may be made by use of the standard apparatus, with the water bath replaced by a bath of glycerine. The value given above is to be regarded as tentative only, as experiments thus far made have included samples of powder made at the torpedo station only.

(c) *Ballistic properties.*—The finished powder shall give the required velocity within a maximum pressure, the values to be prescribed by the Department for the various calibers.

Bids were opened on September 3 for 1,000,000 pounds of powder made according to these specifications and they reached to 79½ cents per pound.

Under the title "An American Smokeless Powder," *Sci. Am. Sup.* 46, 18,946-18,947; Aug. 27, 1898, Frederick H. McGahie says, among other statements: "An American powder, the Maxim-Schüpphaus, offers a superior and scientific solution of

the problem whose correctness has been proved by trials and tests extending over the last four years. It is the standard of the United States army, and, after futile attempts to produce a satisfactory powder of their own, the United States navy has lately adopted it.

"The formula employed during its development was 90 parts mixed gun-cotton, 10 parts nitroglycerine, 1 part urea, the nitroglycerine being added principally to insure good ignition. But the M. S. powder is not a definite one. The formula can be varied widely so as to meet all beliefs of ordnance experts."

It will be interesting to compare these statements with the foregoing specifications and reports.

In the "Report of the Chief of the Bureau of Ordnance to the Secretary of the Navy for 1897,"* Commodore O'Neil says of the work at the Naval Torpedo Station, considerable quantities of gun-cotton and smokeless powder have been manufactured during the past year and researches have been made resulting in the development of a special variety of nitro-cellulose, soluble in ether-alcohol, forming a colloid of extreme toughness, that burns progressively in a very regular manner and which may be converted directly into smokeless powder, decomposing wholly into gaseous products, and possessing a high ballistic efficiency. With the new form of colloid velocities of about 2500 f. s. have been obtained with 5 and 6-inch R. F. guns with pressures of about 16 tons per square inch, and velocities of 2800 f. s. are readily obtainable with the 1-pounder R. F. within the pressure limit of 15 tons per square inch. The powder is quite smokeless.

The problem of the development of smokeless powder may be considered solved, and as the capacity of the factory at the torpedo station is insufficient, orders for 100,000 pounds each have been laid with a firm on the Atlantic coast and one on the Pacific coast for smokeless powder made in conformity with the Bureau's formula. The deliveries have been made in part and the powder will be issued to vessels in commission so soon as it can be procured and prepared.

The Bureau is of the opinion that for national and economic reasons the Department should own and operate a smokeless-powder factory, at which it could produce a part of the powder

* Washington, Government Printing Office, 1897, pph. 66 pages.

required for the naval service, and an item (\$93,727) has been inserted in the annual estimates for this purpose. The property known as Bellevue Magazine, on the Potomac just below Washington, would be an excellent site, and it is conveniently reached by water and by railroad, and is but two hours' distance from the Naval Proving Ground. The present price of smokeless powder procured by purchase is very high, and the Bureau believes it can produce it in large quantities at a greatly reduced price. The success of the Bureau with its gun factory encourages it to believe that it could do equally well in the manufacture of other munitions of war.

The reserve supply of powder on hand is limited, and no effort has been made to accumulate a large quantity, owing to the uncertain state of the development of powders and because it was believed that the brown powders now in use must soon give way to the improved smokeless powders. A point has now been reached when a satisfactory powder of the latter class has been developed, which is believed to possess excellent keeping qualities and to be superior in every way to the brown powders; and the Bureau recommends that a quantity sufficient to refill all the vessels of the Navy be procured, and with this in view has inserted an item (\$1,000,000) in the annual estimates to begin its accumulation.

Commander Conden, Inspector of Ordnance in charge of the Naval Proving Ground, says the manufacture of a satisfactory smokeless powder has been established, and samples have been tested for all calibers and the powder is now being supplied for all guns up to and including the 6-inch. Powder for the 13-inch B. L. R. was tested in February, 1896, and samples still on hand (September 10, 1897) in the magazine have undergone no change so far as can be judged. The results in all cases are higher velocities with lower maximum pressures than with brown powder, and, coupled with the absence of obscuring smoke, it may be said that the offensive power of every vessel in the Navy will be very sensibly increased by the introduction of these powders. We may congratulate ourselves that we were not led by the apparent difficulties of the situation to adopt the very dangerous nitroglycerine powders that have been very generally adopted in other navies. Our own experience with such powders showed their very dangerous lack of keeping qualities.

Tests have been made of the Gathmann projectile designed to carry very large charges of wet gun-cotton. The essential feature of the projectile is the attempt to use a very thin wall, giving great space for the charge, by equalizing the pressure on the inner and outer surface of the shell. This is done by making the caliber of the projectile considerably less than that of the gun except at the head, where the rifling band is placed and allows free play of the powder pressure upon the outer walls, while a movable piston in the rear transmits the same pressure to the interior walls. A 13-inch tube bored out to 12 inches, fitted with breech-mechanism, chambered to suit the projectiles and rifled for part of the way, and projectiles with walls $\frac{1}{4}$ -inch thick were used, but though the projectiles were filled with inert material they broke up under 6 tons pressure. On increasing the thickness of projectile wall to $\frac{1}{2}$ -inch they stood a pressure of 8 tons and reached a velocity of 1686 f. s. Such a shell loaded with 307 pounds of wet gun-cotton was tested in the gun June 9 with the result that the gun was destroyed, pieces being thrown to more than a mile distance and in every direction.

In connection with these tests experiments were made to determine the effect of the superficial explosion of large charges. Two steel plates, 13 feet by 7 feet by $\frac{5}{8}$ inch, were fixed vertically on the beach 50 feet apart, being parallel to one another and securely braced. The plates were slightly curved and the *curved* (?) sides were toward each other. A Gathmann projectile, containing about 340 pounds of wet gun-cotton, was placed on the beach between the plates, 35 feet from one and 15 feet from the other, and fired by electricity. The explosion was of a high order and locally severe, very small fragments of the shell being found in the vicinity, but the plates remained uninjured, not even being displaced, and no effect of any kind was produced on them. A second Gathmann projectile of the same size, loaded with 220.25 pounds of shell powder, was fired in the same position between the plates with practically the same results except that there were rather larger holes made in the ground. A third Gathmann projectile, containing 307 pounds of wet gun-cotton, was hung against the face of an armor plate standing vertically against a target structure. The plate was 7.5 by 16 feet, 16.5 to 9.5 inches thick and weighed 28 tons, and it had received two test shots for acceptance before this experiment. The shell was

supported on wooden blocks against the middle portion of the plate, so that the whole length of the shell bore horizontally against the plate, and fired by electricity. An explosion of the first order occurred, but the damage to the plate was nil. The face of the plate was fused and burned over a space of 5 feet 10 inches by 8 inches to a maximum depth of $\frac{5}{8}$ inch. The side of the shell next to the armor plate was flattened out and burned into a ragged sheet 5 feet 7 inches by 8 inches. A chicken tied on the ground immediately in the rear of the plate was uninjured; one placed in a cofferdam 50 feet from and in front of the plate was uninjured; one placed in a cofferdam 25 feet from and in front of the plate was killed; one placed unprotected on the ground 43 feet from and in front of the plate was scorched and struck by flying fragments. The abstractor understands that these charges were fired with primers of dry gun-cotton. It is to be regretted that the dimensions of the craters formed were not recorded, as these furnish useful criteria.

Tests of randite for comminution were made by filling a 4-inch wrought-steel common shell with 3 pounds 12.5 ounces of the explosive and firing by electricity in a shed fitted up for the purpose. The explosion was very violent and the shed badly wrecked. In a second test a 4-inch A. P. projectile was charged with 6.7 ounces and exploded with a service single-wire electric primer. The explosion was violent and prompt, and the projectile was broken into many fragments. The explosive seemed very mild and inert when burned in the open air—in fact, difficult to burn—and also very insensitive to shock.

Joveite has been tested at various times during the year as a charge for armor-piercing projectiles with satisfactory results. Some failures were recorded in the early trials, detailed in the last annual report, due to an insufficient igniting charge of black powder in the fuse. Three 6-inch A. P. projectiles were fired through a half-inch steel plate with excellent bursts and break-ups. Two 6-inch A. P. were loaded with joveite on November 24, kept in the magazine until May 6, and then tested with most excellent results, using high pressures, a velocity over 2000 f. s. and a steel plate one and a half inches thick. A 6-inch A. P. projectile was fired with a velocity of 1860 f. s. at a cofferdam protected by a 4-inch nickel-steel face-hardened plate at a point where the cellulose was 4 feet 8 inches thick. The projectile

passed through and exploded about 3 feet in the rear of the cofferdam. A similarly loaded 6-inch A. P. projectile was fired at a cofferdam having a 5.5-inch nickel-steel face-hardened plate on the outside. The shell broke up after passing through the cofferdam, but did not explode. The fuse was recovered and it evidently had failed to ignite the joveite, some of which was in the fuse stock. Portions of the charge of joveite were also found scattered about. A 10-inch A. P. projectile, loaded with 8.75 pounds of joveite, was fired through a 4-inch steel plate on August 28. The explosion took place immediately in the rear of the plate, as was determined by marks of fragments of the projectile in the structure supporting the plate. The results were observed from the launch in the river. The break-up of the projectile was excellent, many pieces scattering along the shore and the surface of the river for a quarter of a mile. The largest fragment found weighed not more than three pounds.

Since the above report was written a 10-inch Carpenter, capped, A. P. projectile loaded with 8.25 pounds of joveite and fused, having a total weight of 523 pounds, was fired with a velocity of 1860 f. s. against a side armor plate of the Kentucky, the impact being at a point where the plate was 14.5 inches thick. The projectile completely perforated the plate and as the fuse functioned properly the projectile burst into a large number of pieces just beyond the plate. There was some slight color from unburned joveite. Ten pieces of the projectile were recovered from the sand having a total weight of 198 pounds, the largest fragment weighing 100 pounds. It was evident from the appearance of the timbers that the explosion took place close to the face of the plate and on the rear side, as no portions of the shell were found on the front side.

In another round a 10-inch semi-A. P. Midvale shell, containing 28 pounds of joveite, of a total weight of 511 pounds and unfused, was fired with 230 pounds of powder against the same plate at a point where it was 16 inches thick. The striking velocity was 1925 f. s. The shell penetrated the plate to a depth of about 12 inches and burst with great force. The plate was thrown down and broken through at all previous cracks. Only one recognizable piece of the shell was recovered, and this was a portion of the base plug which had been sheered off longitudinally and from

which a portion of the screw threads had been entirely removed. This breaking up of the base plug seems evidence of a severe explosion, as in no other case has a base plug been found thus broken.

It may seem proper in this connection to call attention to the article on "High Explosives and Modern War Vessels,"* *Engineer*, December 24, 1897, and *Jour. Roy. U. S. Inst.*, **42**, 475-477; 1898, and to Sir Charles Dilke's† article, republished elsewhere in these Proceedings.

Through the courtesy of Mr. Hudson Maxim, we are in receipt of the following pamphlets containing his work: "A New System of Throwing High Explosives from Ordnance," which is a lecture delivered before the Royal United Service Institution, and reprinted April 15, 1898, from its Journal, in which he describes his invention through which he seeks to provide an aerial torpedo projectile which shall carry a maximum of high explosive with a minimum weight of metal, and at the same time be of such constitution, strength and integrity as to enable it to withstand the shock of acceleration and the pressure of the propelling gunpowder charge, without danger of disruption or distortion of the torpedo or its premature explosion. The torpedo is to be thrown from a light-walled large caliber gun by a charge of Maxim-Schüpphaus torpedo powder, giving a pressure of 10,000 pounds, and to be exploded by a Maxim-Alger fuse. No armor penetration is claimed for the projectile, but the large mass of explosive to be thrown is expected to work havoc.

The second pamphlet is a separate from the *Cosmopolitan Magazine* **25**, 327; July, 1898. It is entitled, "The Engineering Problem of Aerial Torpedoes." The third pamphlet, entitled "Aerial Torpedoes," is reprinted from *Cassier's Magazine* for 1898, and each of these treat of the same subject and traverse much of the same ground as the first, though they are variants.

The fourth pamphlet, reprinted from *Engineering*, June 10, 1898, is entitled the "Maxim-Schüpphaus Smokeless Powder," and deals with the method of producing the multiperforated grain and the manner in which it burns. All these articles are well illustrated and are worthy of examination.

* Proc. U. S. Nav. Inst. **24**, 367-370; 1898.

† Proc. U. S. Nav. Inst. **23**, 740-741; 1897.

We are again indebted to the courtesy of Lieut. W. R. Quinan, superintendent, for the following detailed account of the circumstances attending a recent explosion at the California Powder Works, Pinole, California:

"I have to report that one of our nitroglycerine houses (the new one) was blown up about 1.30 A. M. on the 27th of July, 1898. There were two distinct explosions a few seconds apart. A number of our men went to the scene, manned the fire hose and put out several small fires that started on the site. As soon as it was light enough a large gang of men was put to work to clean up the debris. While they were engaged in this work a second explosion took place (about 5.30 A. M.), which killed four and wounded ten of our men.

The circumstances attending the explosion so far as known were as follows: The house has been in operation since early in June. It was in good order and worked almost perfectly. Since we have been using the Rodeo water we have been bothered somewhat with scums in the waste tanks and in the filters. This is chiefly chalk precipitated from the water by the soda we use in washing. It gives trouble by clogging the filters and making slums in the wash tanks. It holds a little nitroglycerine, and this is so difficult to separate that lately we concluded to throw it overboard rather than let it accumulate. To this end our men have collected it in wash tubs which were periodically taken down to the wharf and dumped. Having some repairs to make to the acid cooling department, which could be best done while running the old nitroglycerine house, we concluded to shut down the new house for a few days and to take advantage of the chance to put in a settling tank for the chalk and to put in a new piece of apparatus, viz., a water-lift, to lessen the labor of the men in handling the slums. The house was accordingly shut down on the 26th (after the work for that day was finished) and cleaned up. The last man of the nitroglycerine gang left the house 3.30 P. M. Attended by Mr. Bermingham, the head carpenter and head lead-burner, I visited the house about that hour to give directions about the changes in the house.

The situation in the house was as follows: All the apparatus, including mixers, separators, drowning tank, wash tanks and waste tanks had been cleaned and washed out. The last charge had been filtered and sent down the flume and the switch broken.

The chalk slums had been collected and put in two wash tubs and mixed with sawdust. (This is done for safety in handling on the cars.) The tubs were placed on a brick pavement in the basement of the building. The only other explosive matter in the building was a little nitroglycerine mixed with acid that always drains back into the blow-cask (a steel vessel to pump with compressed air the waste acid from this building up to the acid cooling house), and a little nitroglycerine held by capillarity in the salt filters on the lower floor of the building. The small amount of unwashed nitroglycerine which the men could not collect and wash in time was sent down to the outside waste tanks about 100 feet away. The house was cleaned up with special care as we wished to put carpenters to work at once in the building. Four of them began operation before four o'clock and worked all the rest of the afternoon.

The amount of nitroglycerine in the blow-cask was unusually small. The foreman, Mr. Graves, an hour after the last charge had been pumped up, gave the cask a second blowing with air. We have used blow-casks over 11 years. We have never had any accident with them except once when a cask was left lying in the hot sun for several days. The basement of this house was cool. The situation was such that it would be a stretch of imagination to suppose a spontaneous explosion either in the cask or in the tubs which contained nothing more harmful than a crude low grade dynamite. However, we have been saved any speculation of this kind. There is indisputable evidence that the explosion was not spontaneous.

Just before the disastrous explosion about 5.30 A. M. a piece of *freshly* burnt fuse about five feet long was found in the shattered lumber which the men were hauling away from the building. Four men testified before the coroner's inquest to the finding of this fuse, which was handed to Mr. Bermingham a few seconds before the disastrous explosion. The conclusion is that some miscreant stole into the house in the dead of night and blew up the tubs. These exploded the blow-cask, which was about eight feet away and above the level of the tubs.

A close examination of the wreck seemed to show that the tubs exploded first; also that the blow-cask was moved from its seat before it went off. There was no crater or disturbance of the ground immediately under its usual seat. The serious dam-

age done was confined to the lower part of the house. The wash tank floor was partly thrown down, two of the three wash tanks toppled over, the roof fell and the filters were covered with miscellaneous debris. The second disastrous explosion came from the filters while the men were working directly over them. The amount of nitroglycerine here was very small. We regain the nitroglycerine by dissolving the salt, so that we can estimate the quantity quite closely. There were not more than ten pounds at the outside and it was scattered through about 400 pounds of wet salt.

Our men in cleaning up the debris acted for the best. They believed there was no danger in working over this and they thought it prudent to clean the place up before the sun came with the heat of day to cause possible trouble. The simplest theory to account for the disaster is that when the blow-cask exploded a little acid and dirt was thrown into the filters and this set up a chemical action which culminated in explosion about four hours afterwards. The stuff being brought to the critical point may have been set off by a slight jar, but in regard to this it is useless to speculate. Under ordinary conditions I do not think a fulminate cap would have exploded it.

There is one more point to be noted. The tubs (ordinary wooden wash tubs) were old dynamite carriers and held a lot of nitroglycerine absorbed into the wood—about 12 or 15 pounds each, taking the gain in weight as a criterion. It was this that did most of the damage to the building and not the mixture of scum and sawdust. The amount of nitroglycerine in the latter probably did not exceed five pounds and there was such a large admixture of sawdust it was barely explosive."

"Explosive Materials."* The phenomena and theories of explosion and the classification, constitution, and preparation of explosives, by John P. Wisser. This book is issued as No. 70 of Van Nostrand's Science Series, but it must be remembered by bibliographers that it is a distinct work, as the original contained a translation of Berthelot's *Lecture on Explosive Materials*, by Dr. Marcus Benjamin, a translation of Braun's *Historical Sketch of Gunpowder*, by Lieut. John P. Wisser, and a *Bibliography of*

* New York, D. Van Nostrand Company, 1898; sm. 8vo., 160 pp.

Works on Explosives, by Mr. W. H. Farrington. The first edition having become exhausted, it became necessary, in order to keep the series complete, to issue a new edition, but as, in the fifteen years which have elapsed since the appearance of the first edition, many changes have taken place in the views held regarding the phenomena of explosions and many new explosives have been produced, particularly the important class of smokeless powders which have attracted attention, it was deemed best to have the book rewritten, and this work was wisely put into the hands of Captain Wisser. The subject-matter of the present volume is based on the original essay of Berthelot, but the theories set forth by him are modified by those that have been formulated by Cooke, Abel, Threlfall and Mendeléef, and Captain Wisser has blended these into a most lucid presentation of the subject as now most generally accepted. In addition to this, Captain Wisser has given sufficiently clear descriptions of a large number of explosives and of the processes of manufacture of the more commonly used ones to satisfy the needs of the average reader or military man. In fact, it is surprising that he has been able to put so much information into a "pocket volume." It is to be regretted that the publishers have not given the work a setting equal to its merit and that many of the pages should be distinctly offensive in their make-up. The book ends with an ample index.

"Manual of Military Field Engineering,"* for the use of officers and troops of the line, by William D. Beach, is the second edition of a work by Captain Beach in the revision of which he has collaborated with Lieut. Root and Lieut. Slavens, and which has been approved by the Secretary of War for special study by officers of the army subject to examination for promotion. Upwards of twenty pages of the book and three plates are devoted to the use of explosives in military demolitions. The usefulness of the book would be improved by a table of contents.

"Scientific American Army and Coast Defense Supplement" † is a collection of articles on gun, projectile, armor and explosives which have appeared from time to time in the Scientific

* Kansas City, Hudson-Kimberly Publishing Co., 8vo, 1897, 282 pp., 60 plts.

† New York, Munn & Co., 1898, 1g. 8vo, 64 pp., 110 Ill.

American and Scientific American Supplement, and which were believed to be of popular interest during the war. The articles are of varying merit and accuracy, but the cuts are attractive.

"Lectures on Explosives,"* by Willoughby Walke, is the second revised and enlarged edition of a course of lectures prepared in 1891 especially as a manual and guide in the laboratory of the U. S. Artillery School at Fort Monroe, and which has now been officially adopted for the examination of officers of artillery for promotion in the corps. The work is well arranged and published in good form.

"Notes on Cordite"† is the title of a trade circular issued by Kynoch, Limited, of Birmingham, England, which contains excellent cuts of the Lion Works at Wilton, the cordite and nitroglycerine works at Arklow, Ireland, machinery for blending cordite, cartridges of cordite for different calibers and other cuts. The pamphlet treats of the relations of smokeless powder to gunpowder, describes in general terms the manufacture of smokeless powder, dwells upon the question of the sensitiveness of smokeless powders to climatic changes, and states that cordite has been proved, both in India and Canada, to have maintained the same velocities and pressures as at the test ranges at home. Referring to the objection that the heat it develops tends to erode the barrel of a rifle, it is claimed that an ordinary .303 magazine rifle will fire 10,000 rounds of cordite without becoming unserviceable. Also it is stated that the conditions under which cordite is accepted by the British Government do not allow an extreme variation between the maximum and minimum velocities of the projectile greater than 40 or 50 feet per second in a speed of 2300 feet per second, and that in practice the mean deviation usually does not exceed 10 feet. Tables are given for the charges, muzzle velocities and steel plate penetration with cordite for each of the calibers from .303 rifle up to 6-inch Q. F., and comparison is made with gunpowder for five of these calibers, but no mention is made of pressures.

* New York, John Wiley & Sons, 1897, 8vo, 435 pp.

† Wilton, Birmingham, Kynoch, Limited, no date, 4to, 22 pp., 13 Ill.

Arms and Explosives **6**, 40; 1897, reviews "Des poudres pyroxylin pour fusils de chasse." * Quelques mots de réponse au résumé de la conférence donnée le 18 Janvier 1897 par M. Jules Polain. By Henri Quersin.

The *Revue d. Artil.* **51**, 608; 1898, announces "Treatise on Service Explosives" † (official) and "Regulations for Magazines, Ammunition Stores, Laboratories," etc. ‡ (official); also in **52**, 196; 1898, "La plastoménite," § by General Wille.

* Brussels, Paul Lacomble.

† London, Eyre & Spottiswoode, 1895, 8vo, 126 pp.

‡ London, Eyre & Spottiswoode, 1894, 8vo, 190 pp.

§ Berlin, Eisenschneider.

SPECIAL BULLETIN. } ABSTRACT OF THE LOG OF THE CHRISTOBAL COLON FROM APRIL 8TH TO JULY 3RD, 1898.

U. S. FLAGSHIP NEW YORK. } (The Sea-Day from Noon to Noon was used.)

Date.	Course.	Distance.	NOON POSITION.	WIND.	Revolutions.	Steam.	No. of Boilers.	Coal.	REMARKS.
			Latitude.	Direction.	Force.	lutions.	Preser.	consum'd.	
April 8-9	S. 47° W.	230.0	34° 02' N.	S. E. & E. N. E.	3-6	60-62	120-140	7 81 tons	Left Cadix in company with Maria Teresa (Flag) 4.37 p. m. April 8th 1898. Roll 10° to 20° period 6.5 a. Celebrated High Mass at 10. Read Art. of War. Published G. C. M. Order.
9-10	S. 45° W.	284.0	30° 40' 11" N.	N. N. E.	5-6	50-65	110-140	6-7 83 tons	Sighted Tenerife ahead. Exchanged signals by International code. Pilot board with sealed package for Captain.
10-11	S. 41° W.	235.0	28° 00' 51" N.	N. N. E. to N.	4-7	40-60	110-130	4-6 66 tons	No. 2 gun failed to turn; found the fault and remedied it. After part exercised Small arms.
11-12	S. 34° W.	310.0	23° 54' 13" N.	N. E. to N.	3-5	60-63	130-140	7 85 tons	The after part exercised at Carlines in the afternoon. 9.40 a. m. flagship anchored. At 10.08 anchored in 8 tons. Pajarcas Id. N. 20° W.; Fort, N. 70° S.; West point, N. 13° E.; in St. Vincent, Cape de Verde Is.
12-13	S. 36° W.	279.0	20° 11' 07" N.	N. E.	4	54-60	120-130	6-7 73 tons	Doubled the guards and redoubled vigilance, two steamers came in and anchored. Kept Battery (secondary) ready for action.
12-14	.....	....	.....	N. E.	4-5	54-56	130-130	6	Coaling from lighters.
14-15	At anchor in St. Vincent, Porto Grande.								At 8 p. m. went into sea watches; extinguished all unnecessary light from outside view. Distilling. Two steamers came in and anchored. Kept Battery (secondary) ready for action.
16-17	in 16m water	do	and 45 tons on port chain.						Coaling from lighters.
17-18	do	do							Coaling from lighters. Shifted anchorage to following bearings: Pajarcas Id., N. 17° W.; Fort, N. 73° E. The Spanish mail steamer San Francisco entered during forenoon watch.
18-19	do	do							Finished coaling in the 4 to 8 (evening) watch. Cleaning ship. The Almirante Oquendo and Viscaya came in and anchored during the forenoon watch.
19-20	do	do							The Commodore and Captains met on board at 1.00 p. m. in obedience to signal, they left at 5.00. Exercised 12 c-m and 15 c-m guns of battery from 10 to 11 a. m.
20-21	do	do							Exercised great guns from 10 to 11.15 a. m.
21-22	do	do							After part exercised carbines from 2 to 4 p. m.
22-23	do	do							Lighter with 30 tons coal came alongside during first watch; commenced coaling at 4 and finished 8.00 a. m. Another lighter with 78 tons came alongside during forenoon watch, from which took 25 tons by noon.
23-24	do	do							Afternoon watch Commanding Officer Teresa came on board—commenced coaling 1.30 p. m.—4 to 8 watch another coal lighter with 50 tons arrived; finished previous one; at end of watch about 25 tons left in lighter. 8 to 13 p. m., 54 tons more came. Finished coaling during forenoon watch.
24-25	do	do							Lighters came alongside during p. m. with coal and a 76mm gun for the destroyer Furor, together with 8 bbls. Olive Oil and 2 cases mineral oil (44 tons loose coal and 45 in bags).
26-27	do	do							P. M. 89 tons coal, artillery stores and supplies for the Furor, and wines and provisions came alongside. Coaling. Rec'd 4 boxes exercise torpedoes and a 75-mm gun for Furor.
27-28	do	do							Receiving coal loose, 21.5 tons, and in bags, 20.0 tons, and store for the Furor. Sent to the Furor 16 cases of stores. Finished coaling during forenoon watch.
28-29	S. 58° W.	22.0	16° 52' 40" N.	N. E.	2-4	49	120	5 11 tons	Left Porto Grande, a. m. April 29, in company with Infanta Maria Teresa (flagship), Oquendo, Viscaya, and destroyers Furor, Terror and Pluton.
29-30	S. 56° W.	99.0	16° 45' 52" N.	N. E.	3-5	45-50	90-120	5 32 tons	Torpedo-boats in tow. Trouble with st'b'd air pump. 60 revs. with port engine. Exchanged signals.
30-1	S. 56° W.	120.0	16° 29' 30" N.	N. E.	3-4	40-43	110-120	5 33 tons	Steaming with port engine, helm 10° port. Towing Furor. Reported st'b'd engine ready noon; watch by sig. Held divine service.

SPECIAL BULLETIN. } ABSTRACT OF THE LOG OF THE CHRISTOBAL COLON FROM APRIL 8TH TO JULY 3RD, 1898.—Cont.

U. S. FLAGSHIP NEW YORK. } (The Sea-Day from Noon to Noon was used.)

Date. May.	Course.	Dis- tance.	NOON POSITION.		WIND.		Revo- lutions.	Steam Presur.	No. of Boilers.	Coal consum'd.	REMARKS.
		Latitude.	Longitude.	Direction.	Force.						
1-2	S. 84° W.	162.0	16° 13' 53" N. 28° 54' 27" W.	N.E. to E.N.E.	3-4		40	100-120	5	29 tons.	Terrace towing Pluton; Oquendo towing Terror; we towing Furor. Tried elec. primers 11 a. m. Slowed down to allow the Oquendo to rescue her tow.
2-3	S. 85° W.	162.0	16° 01' 00" N. 29° 58' 30" W.	E.N.E.	3		40-42	100-120	5	28 tons.	Repaired Capitan damaged at St. Vincent. Terror signalled to fire. Signal made to exercise frequently at General Quarters at unexpected times day and night without previous notice being given.
3-4	S. 83° W.	176.0	15° 43' 30" N. 32° 51' 15" W.	E. to E.N.E.	1-2		40	100-120	5	29 tons.	Terror had firing drill in the afternoon. Slowed to renew tow p. m. then proceeded.
4-5	S. 84° W.	170.0	15° 30' 00" N. 33° 43' 15" W.	E.	3		40	100-110	5	28 tons.	Screw of torpedo-boat fouled by fotsam at 9.05 a. m.; stopped and cleared it; started ahead at 10 a. m.
5-6	S. 84° W.	170.0	15° 16' 16" N. 33° 34' 45" W.	E.	3		40	100	5	30 tons.	Towing Furor. Forenoon flagship signalled "We are steering by hand."
6-7	S. 85° W.	170.0	14° 59' 55" N. 41° 24' 15" W.	E. to N.E.	2-4		40-44	98-105	5	30 tons.	Artillerists given theoretical instruction. Slowed from 10.30 to 11.15 a. m. to allow flagship to renew tow.
7-8	S. 84° W.	180.0	14° 44' 20" N. 44° 27' 30" W.	N.E. to E.	4		44-45	90-100	5	34 tons.	Received permission to try search-lights. Slowed 7 a. m. to renew towline of torpedo-boat which had parted.
8-9	S. 84° W.	170.0	14° 33' 25" N. 47° 18' 15" W.	E.	4-6		44-45	90-100	5	32 tons.	At 8.50 slowed, and at 9.00 a. m. stopped both engines for repairs and cast off tow. Started ahead 10.40 a. m.
9-10	S. 87° W.	160.0	14° 19' 45" N. 49° 56' 45" W.	N.E. to E.	4		41-53	95-100	5-6	32 tons.	Slowed down afternoon watch to repair starboard engine, and at 2.25 p. m. to allow Oquendo to re-pair tow. Stopped during 1st watch to let other vessels catch up.
10-11	S. 86° W.	212.0	14° 13' 20" N. 53° 33' 10" W.	E. to N.	3-6		47-50	90-100	6-5	46 tons.	6.45 p. m. cleared ship for action and sent all hands to their stations to remain there all night. 9.00 a. m. sighted vessel to port; went General Quarters until made her out to be Terror. She communciated with Flagship.
11-12	N. 81° W.	90.0	14° 23' 00" N. 53° 09' 00" W.	E.	3-4		24-33	100-110	4-3	22 tons.	4-8 Muntinque on starboard hand. Beat to General Quarters and kept all hands at their stations. Stopped from 6.15 to 6.15 a. m. Flagship cast off Terror from tow. 7.30 a. m. sent 3rd cutter to Flagship. 7.10 Diamond Rock 4m.
12-13	S. 79° W.	261.0	13° 19' 41" N. 59° 47' 28" W.	S.W. to S.E.	0-4		55-68	100-105	6-3	60 tons.	12.20 p. m. lost sight of Martinique. At 6.45 a. m. secured and went to breakfast. 9.25 a. m. Flagship signalled:—"The vessels, on entering port, will be as clean as possible, and the crews will shift."
13-14	S. 70° W. S. 60° W.	203.0	13° 08' 40" N. 63° 43' 00" W.	S.E.	4-6		32-45	75-110	6	43 tons.	6.30 a. m. sighted Curacao, and at 8.00 it bore N. Forenoon watch the Flagship and Vlaccay entered the harbor; this vessel, the Oquendo and the destroyers remaining outside.

SPECIAL BULLETIN. } ABSTRACT OF THE LOG OF THE CHRISTOBAL COLON FROM APRIL 8TH TO JULY 3RD, 1898.—Cont.
U. S. FLAGSHIP NEW YORK. } (The Sea-Day from Noon to Noon was used.)

Date.	Course.	Dis- tance.	NOON POSITION.	SPEED.	WIND.	Revo- lutions.	Steam Preser.	No. of Boilers.	Coal consu'd.	REMARKS.
May.			Latitude. Longitude.		Direction.	Force.	As Ordered			
14-15	Off S. Coast of Curacao.				S.E.—E.S.E.	4-6	70-90	2-5	23 tons.	At midnight the Santa Ana light bore N. Forenoon watch lowered 3rd and 4th cutters, and took Ter- ror in tow. Moving engines at times to maintain position near Orquendo.
15-16	N. 48° W.	110.0	13° 28' 00" N. 64° 28' 16" W.	4.0—9.0	S.E.	3-6	28-45	100-110	5	26 tons. P. 2.30 p. m., having with supplied her with 34½ tons. 6.15 Fluton came out of harbor with Teresa and Vicaça. Stopped and waited for Vicaça to make repairs to engine.
16-17	N. 48° W.	139.0	15° 36' 51" N. 68° 55' 30" W.	5.0—9.0	S.E.—E.S.E.	4-5	45	110	5	40 tons. 2.30 p. m. Flagship made signal—"If you want a cow send boat." Answered—"Many thanks, do not require any." At 7.30 p. m. went to General Quarters and kept crew at stations all night. Morning watch signaled—"Orquendo change station with Vicaça." Admiral intends making port of Santiago. "Be prepared for action to- morrow." Light in case of enemy appears.
17-18	N. 48° W.	168.0	17° 32' 00" N. 68° 50' 00" W.	5.0—8.5	S.E.	4-3	28-34	105-110	4-5	33 tons. At 4.30 a. m. sighted island of Cuba ahead. Entered Santiago harbor on the morning of the 18th of May. Anchored at 8.30 with 15 fathoms on starboard chain; bottom of May. Checked by Mesdrea, ("Day's or "Current Events").]
18-19				5.0-12.5	S.E.—N.N.E.	0-6				At 4.30 a. m. sighted island of Cuba ahead. Entered Santiago harbor on the morning of the 18th of May. Anchored at 8.30 with 15 fathoms on starboard chain; bottom of May. Checked by Mesdrea, ("Day's or "Current Events").]
19-24	Santiago de Cuba, do									At 4.30 a. m. sighted island of Cuba ahead. Entered Santiago harbor on the morning of the 18th of May. Anchored at 8.30 with 15 fathoms on starboard chain; bottom of May. Checked by Mesdrea, ("Day's or "Current Events").]
24-25										At 4.30 a. m. sighted island of Cuba ahead. Entered Santiago harbor on the morning of the 18th of May. Anchored at 8.30 with 15 fathoms on starboard chain; bottom of May. Checked by Mesdrea, ("Day's or "Current Events").]
25-26	Anchored with springs on cables, in Gaspar Bay.									At 4.30 a. m. sighted island of Cuba ahead. Entered Santiago harbor on the morning of the 18th of May. Anchored at 8.30 with 15 fathoms on starboard chain; bottom of May. Checked by Mesdrea, ("Day's or "Current Events").]
26-27	Anchored in Gaspar Bay.									At 4.30 a. m. sighted island of Cuba ahead. Entered Santiago harbor on the morning of the 18th of May. Anchored at 8.30 with 15 fathoms on starboard chain; bottom of May. Checked by Mesdrea, ("Day's or "Current Events").]
27-28	do									At 4.30 a. m. sighted island of Cuba ahead. Entered Santiago harbor on the morning of the 18th of May. Anchored at 8.30 with 15 fathoms on starboard chain; bottom of May. Checked by Mesdrea, ("Day's or "Current Events").]
28-29	do									At 4.30 a. m. sighted island of Cuba ahead. Entered Santiago harbor on the morning of the 18th of May. Anchored at 8.30 with 15 fathoms on starboard chain; bottom of May. Checked by Mesdrea, ("Day's or "Current Events").]

ABSTRACT OF THE LOG OF THE CHRISTOBAL COLON FROM APRIL 8TH TO JULY 3RD, 1898.—Cont.

(The Sea-Day from Noon to Noon was used.)

Date day.	Course.	Dis- tance.
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Noon to 4 p. m. various North American vessels in sight, among which could be distinguished the Iowa, Indiana, Brooklyn and Texas type and some merchantmen. 4 to Mid American vessels continue to pass by mouth of harbor with their search-lights thrown on the coast. At 4.00 a. m. the two destroyers returned, having been cruising at the mouth of the harbor and reporting enemy's vessels from W. to E., from point, i. e.: B. T. Ind-la, a yacht and merchantmen. The Ensign of the Platoon, on passing this vessel on way to the Flagship, reported having been within about 4 miles of the enemy's vessels. At 11.00 sent an officer and 3 Quartermasters to the main force, with three military tops on each; and two smokestacks, by semaphore; and by flag signals announced the arrival of a man-of-war with two masts, with three military tops on each; and one armed merchant vessel. At Noon to 4 P. M. paid the crew; at end of watch 4 enemy's vessels in sight which appeared to be the B. Min. Tex.; and the mouthed merchant vessel. At sunset two enemy's vessels below horizon. During mid watch the destroyers and vedettes cruised several times to the mouth of the harbor, and when one of the vedettes returned it signalled the letter K with the Colomb signals and then disappeared behind Cay Smith. Morning watch ten men to coal torpedo-boats; semaphore signalled:—"Enemy's Squadron In sight" and at end of watch "Two shots to the W'd."

	Position.
Anchored In Gaspar Bay and at Ratonnes Key.	
May. June.	
21—1	

At 1.15 sent 10 men to coal Platoon. At 2.15 the Iowa passed W. to E. at short distance firing at us; beat to General Quarters—2.15 to 5.00 p. m. BombarDED by the enemy's Squadron from S. w. m. At General Quarters for action. As soon as the enemy's Squadron opened fire and was standing across the mouth of the harbor from the western point and heading to the Eastward at high speed, and consisting of the Iowa (flag), Massachusetts, Brooklyn, Amazonas, Texas, Marchhead, City of Rome (apparently), and four auxiliary cruisers; we commenced firing with the port 15 cm. battery, which continued with rapidity, and correcting the excellent conveniently in order to diminish tendency to waste ammunition. Then commenced with the 15 cm. guns and continued the firing during the time it took them to cross the mouth of the harbor. The Amazonas and large transatlantic steamer having stopped, we then concentrated all our fire on them both. In a short time the other battleships returned, and then the transport continued on both sides, but our shot falling short on account of the enemy keeping at too great a distance. A battleship, apparently the Brooklyn, and the transatlantic liner remained in front, and repeating our fire, a tug was seen to approach the latter and astern of her the other battleships were nearing the former. Observed they retired, conveying them and another steamer at a greater distance, also appearing to have suffered damage to the SD without answering our fire. At 3.15 H. E. the Comd't Gen'l of the Squadron, came on board in the Teresa's steam launch, and soon afterward ceased firing on account of the silence and withdrawal of the enemy. We were accompanied in our offensive attack by the Bocaupa battery and that of Morro. 62 rounds were fired from the 15 cm. battery and 14 from the 12 cm. The firing-plans of three of the 12 cm. guns and six of the 15 cm. were damaged. When the ships retired it was in disorder and, in our judgment, confirmed the fact that two of them required con-voying by the Brooklyn as already mentioned. Keep the whole port battery loaded, and at 5.00 p. m. resumed sea watches. At 9.30 p. m. six of the enemy's vessels passed from E. to W. across the mouth of the harbor, returning at 11.30 the other way. Semaphore signalled:—"The Flagship has seen a vessel to the E.d. near the coast, and that upon the vedettes going out two shots were heard, and that the enemy's Squadron would pass close by the mouth of the harbor." The Flagship asked the distance; replied that report would be made upon return of vedette. 4 to 8 a. m. the enemy's Squadron in sight, passing the south side of the harbor, first from E. to W., afterward from W. to E., at a great distance and beyond range of our guns; they appear to have been re-inforced by several vessels. At 9.00 a. m. sent men to coal the Furor. At 10.20 a. m., by order of the Comd't Gen-eral of the Squadron, cast off the springs. At 10.35 a. m. got underway, and under direction of the Commanding Officer cast to starboard and under slow speed passed between Punta Gorda and the bow of the Oquendo. Directed our course into the inner harbor until 11.50 a. m. at which time we came to anchor in 9.5m. of water, with 15 fathoms on port chain; bearings at anchor Ratones Cay, S. 86° W.; Vary Pier, N. 11° W.; and Compadre Rock, S. 80° E.

During afternoon watch unloaded the 12 cm. guns and the 154 mm. battery. 4 to 8 p. m. unable to unload 4, 6, 8, and 10 of the 15 cm. battery. Re-mains show-made signal that the enemy's Squadron was in sight, and at 6.00:—"The enemy is approaching!" The enemy was unloading 4, 6, 8, and 10 of the 15 cm. battery. Remains:-
The enemy was directing his course to the mouth of the harbor."
Afternoon watch semaphore signalled the enemy's Squadron in sight.—3.30 p. m. coal lighter came to starboard side; commenced coaling. Stopped coal-ing at 9. p. m. At 8.25 a. m., hearing a lively firing of guns at the mouth of the harbor, called and armed the crew. got the battery ready, and supplied a case of ammunition for each rapid-fire gun. 4 to 8 a. m., the firing continued at short intervals at the mouth of the harbor. Lighted two boilers and shifted closer to Ratones Cay with 15 fathoms on port chain and ready to receive information notice. Lowered 2nd steam launch and anchored all the boats which were in the water close to the coal lighter. At 7.00 a. m. received information from the Flagship by signal:—"Merchant vessel which had entered the month of the harbor was sunk while towing Niemeo Bay; she was struck by two torpedoes, one from the Pluton and the other on observation mine; we captured one officer and seven North American sailors," 8 a. m. to noon got out ledge with 60 fathoms on it, and secured on the following heurlines:—Ratones Cay, S. 57° W.; Compadre Rock, S. 78° E.; and Julius Lookout, S. 13° E. Signals were made to us concerning the movements of the enemy's vessels.

At anchor In harbor of San-tiago de Cuba.	
1—2	
2—3	

(The Sea-Day from Noon to Noon was used.)

Date.	Position.	REMARKS.
June.		
3-4	At anchor in harbor of Santiago de Cuba.	At 1.00 p. m. H. E. the General Second in Command left the ship; lowered his flag. Flagship made signal:—"Light fires under all boilers and have steam by 6.00," soon afterward:—"Amended, steam on boilers by 10 o'clock." At 8 p. m. semaphore signalled that the enemy's Squadron was approaching. The Flagship made signal:—"Do not let fires go down but have the boilers ready for steam in 4 hours." At nightfall some shots were heard in the direction of the Morro. At 10.30 p. m. cannon-firing was heard at regular intervals and two discharges at the mouth of the harbor. Watering ship.
4-5	do	At 8 p. m. the semaphore made signal:—"The enemy opens fire." After supper armed the crew without loading the small-arms. At 8.30 a. m. steaming ship. The semaphore brought coal lighter to port side; finished coaling during 4 to 8 a. m. watch and commenced taking in water from launch. At 10.00 a. m. held divine service. At end of watch signal still hoisted on semaphore:—"Enemy's Squadron in sight."
5-6	do	At 10.00 a. m. the enemy opened fire. 8 a. m. to noon cast loose and loaded the rapid-fire pieces of both batteries. The enemy's fire lasted until 10.35, being answered by the shore batteries; at this time the semaphore made signal that the enemy was withdrawing to the E'd. At 11.15 firing was again heard to the E'd, which continued to end of watch, though far distant. At 10.30 the Chief of Staff arrived and, by his orders, manned the rapid-fire guns of the Mercedes, which had been installed at the mouth of the harbor; sent two petty officers, four artillery men from the turret's, and thirty men from the turret's, all in command of Lieutenant Grid (or Gust) and Ensign Servet. This force returned on board by order of the Admiral of the Squadron, but upon arrival was held in readiness for immediate departure. Sent several men to the hospital.
6-7	do	Merid. to 4 p. m. sent the 34 men to the Mercedes. Received information of the death of Com'd'r E. Costa, Executive of the Mercedes, and of 5 men; Ensigns M. Dore and A. Molines, and 12 men were wounded. Unloaded the charges from both batteries. At 5.30 p. m. semaphore made signal that the enemy were firing upon the shore; secured the Marymak's boat, repaired it and supplied it with a new rudder.
7-8	do	Taking in water. At 7.00 p. m. four search-lights of the enemy were seen illuminating the shore.
8-9	do	During the afternoon watch launched two torpedoes from the starboard stern tube to test their speed. 7.00 p. m. enemy's search-lights illuminating the shore which continued all night. Held divine service at 10.
9-10	do	The North American ships continued lighting the coast with their projectors, especially the mouth of the harbor. The Viscaya made signal at 9.30 p. m. that the ships were about 8 miles from shore. At 1.00 a. m. same informed the Flagship that the enemy's ships were firing rockets and burning blue lights. 10.30 semaphore signalled that the enemy had opened fire. At end of watch the enemy retired.
10-11	do	The enemy's Squadron kept the shore constantly illuminated with their projectors during the night, especially the mouth of the harbor. Watchword, "Gonzalo"; password, "Gibara"; counternight, "Granatazo"; which signals of recognition were reserved for the large ships; for the torpedo-boats, "Guas," etc., the night letter for the 11th to 12th insts. is "G."
11-12	do	Nothing of importance. Watchword, "Tho"; password, "Ibega"; counternight, "Intento."
12-13	do	Enemy's search-lights illuminating shore and harbor all night. Watchword, "Mueritas"; counternight, "Monlo." Night letter 12 th to 13 th "M"—for to-night.
13-14	do	At 11.15 p. m. heard seven shots which seemed to have been fired from the Socapa. Enemy's search-lights trained on shore and entrance to port all night.
14-15	do	Received on board 5 tons of rice; other provisions alongside. Enemy's search-lights trained on shore and entrance to port all night.
15-16	do	At 11.15 p. m. heard five shots fired, one, apparently, from the Socapa, and the others by the enemy. At 5.30 a. m. the enemy's Squadron opened a heavy fire, aiming at the shore batteries; several projectiles fell inside the harbor. At 6.30 the enemy's fire slackened, and our batteries continued answering them until 6.35.
16-17	do	Enemy's search-lights on port entrance all night. Sent 10 armed men to the Mercedes. At 5.00 a. m. the enemy opened fire to the W'd, on Cabrera Pt., which lasted until 5.45 a. m.; according to signal received this was done by the Texas, a yacht and two steamers. 9 to 10.30 a. m. exercised in landing artillery. Sent launch for water.
17-18	do	Enemy's search-lights trained on mouth of harbor all night.
18-19	do	At 4 to 8 p. m. boat returned from making an examination of the Morrymak. At 10.50 p. m. about 5 shots were heard, evidently fired by the Socapa and Morro at an enemy's ship which had approached within a short distance of the entrance. At 7.00 a. m. heard some cannon shots which subsequently were supposed to be an American yacht saluting the Squadron. Watchword, "Salvador"; password, "Sofia"; counternight, "Sobre." At 10.00 held divine service, and read some of the Articles of War.
19-20	do	Enemy's search-light trained on shore and mouth of harbor all night. At noon an explosion occurred at the wharf; cause unknown. Watchword, "Nica-rio"; password, "Nada"; counternight, "Norio."
20-21	do	Enemy's search-lights trained on shore and mouth of harbor all night. At 7.30 a. m. the General Second in Command came on board in the Mercedes' boat; hoisted his flag. At 11.15 a. m. the Mercedes came on into the inner harbor and anchored.

* A flag officer in the Spanish service is usually spoken of as "General." The officer here mentioned was a "Capitan de Navio" of the First Class, equivalent to our "Commodore."

Date.	Position.	REMARKS.
June. 21-22	At anchor in harbor of Santiago de Cuba.	At 10.45 p. m. shots were heard, apparently from the Veuuvius, which were answered by our batteries. At 8.05 a. m. shots were heard from the enemy's Squadron, which were replied to by our batteries; the enemy continued firing slowly until 11.30 a. m.
22-23		At 10.40 p. m. three shots were heard near the entrance, and also others further off. In obedience to signal disembarked with provisions and ammunition, in two launches, in command of Ensign Gossel and Sagrera. 8 a. m. to noon sent provisions on shore for the landed force. Launch with 30 tons of coal came alongside, which commenced discharging at once.
23-24	do	Requisition for provisions for the company on shore was made upon the Captain of the Port. 4 to 8 p. m. Lieut. Emilio Butron was lent for duty in the Estrella battery. At sunset the enemy's search-light began to illuminate the shore. Ensign Enrique de la Cierva returned from duty in the Estrella. At 8 p. m. armed and kept all hands at their stations. Finished coaling at 8.00 a. m. Sent steam launch with fresh provisions and stores to the company on shore. Sent 60 fixed charges on shore for the pieces with the landed company. At end of morning watch semaphore signalled that the enemy had opened fire on the beach to the eastward.
24-25	do	Semaphore flying signal:—"The enemy is firing at the shore to the E'd." At 1.00 p. m. some cannon shots were heard to the E'd. Sent three days provisions to the company landed at La Cruz. Flagship signalled:—"Guardship Oquendo, doctor Teresa, chaplain Teresa." At 4.40 a. m. heard cannon firing to E'd, and the semaphore signalled that the enemy had opened fire on the beach in that direction. Sent provisions to the detachment at the E'd. Dos Caminos del Cobre, and by the steam launch to that of Los Cruces. At 10.30 semaphore signalled:—"Enemy is firing on the beach to the E'd." Lieutenant Milre left for Estrella.
25-26	do	At 4.00 p. m. several cannon shots were heard, and semaphore signalled that the enemy was firing on the shore to the E'd; shortly afterward and in the next watch two discharges of musketry were heard. At sunset two picket-boats and a destroyer left for outside. At midnight four shots were heard, two of them from the Morro; soon after Viscaya signalled Teresa that the Veuuvius had thrown two shells, the Morro replying with the other two. Enemy's search-lights trained on entrance all night. At 10.00 a. m. the steam launch took provisions to the detachment at Dos Cruces, returning immediately. Held divine service.
26-27	do	4 to 8 p. m. sent cartridges and five chests of Mauser ammunition to the detachment in command of 3rd officer. Got ready the artillery of the port battery. At 10.30 p. m. the Viscaya signalled to Teresa that the Veuuvius, a destroyer and a picket-boat were in front of the semaphore and about 8 miles distant. At 1.16 a. m. two discharges were heard at the Morro; the Viscaya reported that the Veuuvius had thrown three shells, to which the Morro replied. At 2.16 a. m. three shots were heard to eastward, which the Viscaya reported had been fired at Aguadores. At 6.00 a. m. sent steam launch to iron-pier to take 3 cases of ammunition to the detachment at Dos Cruces, and one day's provisions were taken to the other detachment by the menmen.
27-28	do	At 8.45 p. m. musket-firing was heard toward the city, at which the Oquendo reported that infantry firing had been seen in the direction of Dos Caminos del Cobre, which report was transmitted to the Flagship. At 9.00 a. m. Ensign J. M. Arancibia relieved the officer of the torpedo station (hut) at Estrella. Flagship, made signal to hold divine service.
28-29	do	At 1.00 p. m. musket-firing was heard toward the city, at which the Oquendo reported that infantry firing had been seen in the direction of Dos Caminos del Cobre, which report was transmitted to the Flagship. At 9.00 a. m. Ensign J. M. Arancibia relieved the officer of the torpedo station (hut) at Estrella. Flagship, made signal to hold divine service.
29-30	do	At 1.00 p. m. musket-firing was heard toward the city, at which the Oquendo reported that infantry firing had been seen in the direction of Dos Caminos del Cobre, which report was transmitted to the Flagship. At 9.00 a. m. Ensign J. M. Arancibia relieved the officer of the torpedo station (hut) at Estrella. Flagship, made signal to hold divine service.
June. 30-1	do	At 1.00 p. m. musket-firing was heard in the direction of Dos Caminos. At every hour of the first watch shots and musket-firing were heard in the direction of Dos Caminos del Cobre. At 11.00 a. m. an explosion was heard resembling cannon fire near the land, and a boat was sent with rations to the detachment at the Cruces.

7.30 a. m. musket-firing was heard in the direction of Dos Caminos. At every hour of the first watch shots and musket-firing were heard in the direction of Dos Caminos del Cobre. At 11.00 a. m. an explosion was heard resembling cannon fire near the land, and a boat was sent with rations to the detachment at the Cruces.

SPECIAL BULLETIN } ABSTRACT OF THE LOG OF THE CHRISTOBAL COLON FROM APRIL 8TH TO JULY 3RD, 1898.—Cont.
U. S. FLAGSHIP NEW YORK. }
(The Sea-Day from Noon to Noon was used.)

Date.	Position.	REMARKS.
July.		
1—8	At anchor in harbor of Santiago de Cuba.	At 12.30 p. m. firing was heard between the town and Siboney, the enemy firing on the port. Twice artillery and musket-fire was heard at the beach, that of the enemy's Squadron at the port, ceasing at 2.00 p. m., but continued that at the land. The Flagship made signal:—"For to-morrow, Guardship, doctor and chaplain, the Colon." At 5.00 p. m. artillery and musket-firing again heard. Ambulances were seen from on board taking wounded to the hospital. At 2.00 a. m. five volleys of musketry were heard at Punta Blanca. At end of Mid watch Flagship made signal:—"Light area under all boilers," and having asked if we were to light area at once they replied "No, have steam ready by two o'clock in the afternoon." At 5.00 a. m. musketry fire was heard toward the town and shortly afterward fire was opened on the batteries and the bay. Boat to General Quarters for action, kept all hands at their stations and loaded starboard battery.
2—8	do 6 p. m. weighed anchor. 8 p. m. anchored.	

NOTE.—The columns for the 2nd and 3rd are entered up to midnight; but someone has torn out the page of remarks for that day.

PROFESSIONAL NOTES.

SHIPS OF WAR IN ACTION.

We are indebted for the following article, whose importance it is not easy to overestimate, to one of our United States correspondents, who writes: "I have been engaged with a colleague in a critical examination of the operations of the American navy during the present war. Circumstances have given me abundant opportunities to discriminate between the various reports, official and unofficial, which have been published here on this subject. I send you the result, and I am quite certain that every fact stated by me will, sooner or later, be verified in official quarters. The labor which this article has entailed has been enormous, owing to the numerous wild newspaper statements which have had to be hunted down and proved to be untrue before the article could be presented in its present shape."

The net result of the first two months' active naval warfare between the United States and Spain points to a continuation of the policy of building sea-going battle-ships and armored cruisers by all the ambitious naval powers of the world. Between the battle of Manila, fought on May 1st, and the complete destruction of Admiral Cervera's fleet outside of Santiago on July 3rd, the gun-fire on both sides has demonstrated that the ordinary planting of unarmored ships offers no obstacle to the direct fire of common shell timed to burst in the interior of the vessel. At the same time, although the armored sides of the American battle-ships have been struck on several different occasions by Spanish shot or shell, no damage whatever has followed the impact.

The early morning engagement at the battle of Manila, according to Admiral Dewey's official account, lasted one hour and fifty-four minutes. At the end of this time the *Reina Cristina*, the *Castilla* and the *Don Juan de Austria*—the three largest Spanish vessels—and a gunboat were on fire from the effect of the American shells. The range varied from 5000 to 2000 yards, and there is reason to believe that most of the damage was done by the 6-inch guns. Captain Gridley, of the *Olympia*, in an account of the action given by him shortly before his death, says that one 8-inch shell, which struck the *Reina Cristina* near the stern, killed and wounded seventy men. Past-Assistant Engineer Beach, of the *Baltimore*, who visited all the sunken ships after the battle, says that "one smokestack of the *Castilla* was struck eight times; and the shells through the hull were so many and so close that it is impossible that a Spaniard could have lived on her deck. The other large ship, the *Reina Cristina*, was perforated in the same way." Mr. J. L. Stickney, the correspondent of the *New York Herald*, who was formerly an officer in the United States navy and acted as Admiral Dewey's aid during the engagement, says that the captain, chaplain and ninety others were killed and six wounded on

the Castilla, and that 150 were killed and ninety wounded on the Reina Cristina. But we have already seen that 29 per cent. of the killed and wounded on the Reina Cristina was the result of one 8-inch shell, and it is therefore fair to draw the conclusion that well-aimed, properly-bursting shell-fire will be terribly destructive to the crews of unarmored vessels.

Let us now turn to the effect of the badly-aimed Spanish fire on the American ships. One shot struck the Baltimore and went clean through both sides, without injuring anyone and without doing any material damage to the ship. A second shot struck the same vessel, ripped up a portion of her main deck, exploded a box of rapid-fire ammunition, and injured eight men; the only casualties sustained by the Americans during the action. A shell entered the Boston's ward-room, just above the water-line, exploded within 5 feet of Paymaster Martin without injuring him; gutted Ensign Dobridge's stateroom, and set the furniture and combustibles in it on fire. The flames were soon put out with a hose, previously provided for that very purpose. A second shell set fire to the Boston's port hammock nettings; but this blaze was soon extinguished. Other shells hit the masts and rigging of the American ships; one of them burst near Admiral Dewey, on the bridge of the Olympia, and another passed in front of Captain Wildes, on the bridge of the Boston. Captain Gridley says the Olympia was hit thirteen times without injury. It is evident, therefore, that the Spaniards had no lack of guns or ammunition, and that their failure to inflict more damage on their adversaries was the result of bad marksmanship, due either to want of practice or to want of coolness in serving the guns. Let us suppose, for the moment, that the Spaniards had had plenty of gun practice—a very improbable supposition—that we might infer that the heavy and constant fire of the American ships had so flustered them as to destroy the accuracy of their aim. We might parallel such a supposition by pointing out that while the two fires started on the Boston were soon extinguished, the fires on the Spanish ships were allowed to get beyond control.

Leaving aside for the moment, to return to it later, the question of shell-fire, let us examine some aspects of the battle of Manila which have an important bearing on the future of naval warfare. The most cursory examination of the official account of the engagement, as made public by the Navy Department at Washington, shows that many important portions of it have been suppressed, doubtless for the good of the public service. Nothing is said in it, for example, about the shortness of ammunition in the American fleet after the battle was over, though the fact was made sufficiently notorious through the hurried orders telegraphed to the United States cruiser Charleston at San Francisco to ship a large supply of powder and projectiles, and to proceed at once to Manila. The correspondents of the European newspapers in the Far East have also frequently alluded to Admiral Dewey's lack of ammunition until fresh stores arrived on June 30th on the Charleston. A remarkably frank private letter, written by a staff officer of the American fleet to a friend in New York, and published in the *Sun* of June 15th, gives us a good deal of light on this necessarily delicate matter. The first extract from this letter had better be given verbatim: "At 7.30 we got the signal to haul off, and the captains to go aboard the flagship. Up to this time, while some of the smaller craft had run inside the navy-yard slip, we could not see that we had done much damage, and we had not been hurt. We felt very sick at our apparent lack of success. We only

knew later how solemn the conditions were. The commodore was much depressed. Half the ammunition on our ships had been expended, and he began to wonder if he might not better haul off and try to blockade the place. The reply was that if he did this the enemy could harass us, keep us on the *qui vive*, and force us to expend ammunition in night attacks."

The staff officer's letter continues to say that while the captains were in consultation with the Admiral three of the Spanish ships were seen to be on fire. It also says that when the second attack began at 11.16 the Baltimore took the lead because "the Olympia had only thirty-seven shots left for her big guns." Now, we learn from Captain Gridley's account, previously referred to, that the Olympia fired forty-three shots from her 8-inch guns during the engagement. Adding Captain Gridley's forty-three shots fired to the staff officer's thirty-seven shots left after the early morning fight, would give eighty rounds in all, or only twenty for each of the four 8-inch guns. Suppose the Olympia used her 8-inch guns as little as possible during the second engagement, Captain Gridley's account goes far to corroborate that of the staff officer, since forty-three is three more than the half of eighty, and the rapid expenditure of ammunition during the first engagement would explain Admiral Dewey's reason for signalling to cease fire and to order the captains to come on board the flagship, so that he might ascertain how many projectiles each had left on his ship. It is also at least a curious coincidence that English critics of American warships have repeatedly referred to their smallness of ammunition capacity—a fault corrected in the later battle-ships—as likely to prove their chief drawback on active service. Mr. H. W. Wilson, for example, in his "Ironclads in Action," in discussing the United States navy, takes this view when he says: "Only the actual trial of war can settle the question whether, with a given weight for guns and ammunition, it is better to have more guns and less ammunition, or fewer guns and more ammunition"—page 300. That, it may be remarked, depends entirely on the accuracy of the firing.

Two other points in the staff officer's letter may as well be mentioned here. "All that morning (April 30th)," the letter says, "and all day Friday (April 29th) we had been stripping ship and chucking overboard spare loose articles, tables, mess chairs and benches, ladders, everything that would afterward make trouble. All joiner and woodwork on gun deck was torn out and thrown away." Again the letter says: "You never anywhere saw such a wreck as my room was. It got no shot in it, but our own 8-inch guns, fired right across the deck, tore it all to pieces. Everything breakable was broken, and the bulkheads were all started; all the bookshelves were torn out and everything—clothes, electric fan, books, 'baccy, curios, and the rest—was on the floor in one mass. Can you picture it?" The same account also says: "Not one of our boats had we left after the scrap. Four of them we let fall from the davits—what was left of them, and the others will take no end of work to make them hold water." Returning to the effect of shot and shell-fire, we find that the next event of the war in this direction was the disablement of the American torpedo-boat Winslow, on May 11th, by a Spanish land battery in Cardenas harbor. The battery consisted of several 4-inch guns firing at a range of 2500 yards. Although many shots were fired at the Winslow, only two took effect. The first of these was a shell which burst on the deck of the torpedo-boat, killing Ensign Bagley and three men, and wounding two

others. The second shell disabled the Winslow's engines and boilers, wounding two men in the engine-room. As the Spanish battery used smokeless powder, it could not be located by the attacking ships. If the account of the Cardenas fight published in the *New York Herald* of May 14th be true, the Winslow had a very narrow escape from total destruction. A shell from the Spanish battery is said to have struck the forward port torpedo of the vessel and to have passed through the gun-cotton charge without exploding it.

In the attack by Admiral Sampson's fleet on the fortifications of San Juan, Porto Rico, on May 12th, eight shells struck the armored sides of the battle-ship Iowa without doing the slightest damage. A 6-inch shell struck one of the boats in the vessel, scattered the splinters of the boat in all directions, then burst, sending fragments which made fifty wounds in the ship, including four or five perforations of the gun deck, which it set on fire, and a hole in one of the funnels, fortunately injuring only three men. Another shell killed one man and wounded four others on the superstructure of the armored cruiser New York during the same action.

When General Shafter's army began to disembark at Baiquiri on June 22nd, the second-class battle-ship Texas was ordered to shell the western batteries at the entrance to Santiago harbor. A 6-inch gun in one of these batteries discharged a shell which struck the Texas on the port bow between the gun deck and the spar deck, bursting in the forward compartment where there were six 6-pounder guns, with their crews at quarters. Though the steel plating of the ship's side was $1\frac{1}{4}$ inch in thickness, it did not explode the shell, which passed through it as if it were so much paper. About 7 feet from the starboard side it struck a heavy metal stanchion, shattering 2 feet of it into fragments, and burst. The base of the shell ploughed a furrow along the deck until it met one of the ship's ribs, where it broke into two pieces, both of which struck a cable reel, 4 feet in diameter, consisting of 2 feet of hemp hawser and 2 feet of oaken drum. The cable was cut completely through and the oaken drum smashed into splinters. Showers of steel splinters from the shell itself and the metal stanchion which it struck swept along the starboard side of the ship, breaking gun fittings, cutting off heads of bolts, and stripping off paint. One man was killed and eight men were wounded by this shell, and it is especially worthy of note that the smoke from the explosion forced its way down the ammunition hoists and into the forward compartments of the ship, so that for a few moments the crew in that part were almost suffocated. This completes the list of casualties on American ships from shells up to June 30th.

During May and June four attempts were made by Spanish torpedo-boats to injure American warships. The first of these was at the battle of Manila, on May 1st, when two torpedo-boats came out together from Cavite and advanced towards Admiral Dewey's fleet. They were soon seen, and one of them was sunk and the other so badly injured that it had to be beached before either of them came within the maximum torpedo range of 1000 yards. The second attempt was made at night on May 30th, at Santiago, which in competent hands would probably have resulted in the destruction of the Texas. The Spanish torpedo-boat destroyers Furor and Pluton, credited with 28 and 30 knots respectively, were within 500 yards of the Texas when discovered by her searchlights. In spite of a hot fire they retreated back into Santiago harbor without serious injury. Next day two automobile torpedoes were found floating on the surface

of the sea not far from where the Texas had been the night before. One of these torpedoes was in good order ready to explode. The other, through the carelessness of the men who fired it, had only a practice head in it and could have done no damage under any circumstances. On the night of June 3rd the New Orleans discovered a possible torpedo-boat within range of her guns and promptly opened fire. The New York and Massachusetts quickly followed her example, and finally the Oregon sunk the vessel, whatever its character may have been, with a 13-inch shell. During daylight on June 22nd the torpedo-boat destroyer Terror came out of the harbor of San Juan, Porto Rico, and by keeping under cover of the Spanish cruiser Isabella II, attempted to get within striking distance of the United States auxiliary cruiser St. Paul. When the Terror came within a range of 6000 yards the St. Paul let fly her whole broadside, consisting of three 5-inch guns, two 6-pounders, two Hotchkiss rifles and two 3-pounders. Although the guns were said to have carried the range, none of them did any serious damage to the Terror. After firing some fifty or sixty shots at the torpedo-boat destroyer—she fired 100 shots altogether between the two vessels—the St. Paul discharged a last 5-inch shell, which struck the Terror on the port side, near the stern, went clear through into the engine-room, took off the head of the chief engineer, the legs and arms of the assistant engineer, and mortally injured one of the crew who was in the engine-room at the time. It also completely wrecked the Terror's engines, and left her in such a sinking condition that she had to be beached.

Fixed submarine mines, though laid down by the Spanish in considerable numbers, did not prove effective in any single instance. Their greatest chance of success was at Manila, where two separate mines were exploded prematurely as Admiral Dewey's flagship, the Olympia, was advancing to the attack at Cavite. As the American admiral had no knowledge of where these mines were placed, it is possible that in more skilful hands they might have destroyed the Olympia and the Baltimore. The mines which were said to be so plentifully strewn in the narrow and tortuous channel leading to the harbor of Santiago were practically needless precautions, since a few batteries of modern high-power guns could have blocked the channel. Between June 8th and 11th the propellers of two United States warships loosened two submarine contact mines in Guantanamo harbor. On examination it was found that the failure of these mines to explode was due to the incrustations of shell fish on the plungers, which were thus prevented from breaking the bottle of sulphuric acid which was to set off the mine—probably by mixing with chlorate of potash and sugar.

There is no reason, at present, to believe that the numerous bombardments by the American fleet of fortified places in Cuba and Porto Rico did any serious or permanent harm to the earthworks which protected most, if not all, of the Spanish high-power guns. It is true that the older masonry fortifications with their obsolete guns suffered a good deal of damage, but this was only to be expected, as it evidently was, even by the Spaniards themselves. Some good work, however, was done by American gunboats in destroying the smaller shelter forts which the Spaniards had erected along the coast of Cuba to prevent the insurgents from smuggling arms into the interior. At Guantanamo American warships aided a party of 800 marines, who had been landed, by shelling the woods in which Spanish soldiers were ambushed.

The battle of Santiago, ending with the total destruction or capture of Admiral Cervera's fleet, marks the virtual culmination of the naval warfare between the United States and Spain. Although it occurred in broad daylight, and although the fight was a running one, and singularly free from complications, the accounts which we have, both official and other, are full of contradictions on minor points. Taking Admiral Sampson's official report as our main guide, we learn that at 9.30 a. m., on July 3rd, the armored cruiser Brooklyn, and the battle-ships Texas, Iowa, Oregon and Indiana, were on blockading duty, lying in a semicircle in the order named, outside the narrow entrance of the channel leading to the harbor of Santiago; the Iowa lying directly opposite the harbor entrance about four miles from land, at 9.31 first sighted Admiral Cervera's flagship, the Infanta Maria Teresa, coming through the channel. She was followed at intervals of 800 yards by the Vizcaya, Cristobal Colon and Almirante Oquendo in the order named, and at intervals of 1200 yards by the torpedo-boat destroyers Pluton and Furor. On seeing the signal hoisted by the Iowa, Commodore Schley, on board the Brooklyn, and in command of the fleet in the temporary absence of Admiral Sampson on the armored cruiser New York, ordered a general movement inward of the semicircle of blockading ships. The Iowa at 9.40 fired the first shot at a range of 6000 yards, and continued firing as she approached the harbor entrance, until it was seen that the Maria Teresa would pass, heading westward, between the land and the Brooklyn, which had been lying to the west of the channel, about two miles from shore. The Brooklyn, which had been heading eastward, to head off the Maria Teresa, delivered a raking fire from her port batteries at 1500 yards range. The Texas, the next ship to the Brooklyn in the blockading semicircle, opened fire on the Teresa at 4200 yards range. The Iowa, at 2500 yards from the Teresa, put her helm to starboard and delivered her broadside fire. The Oregon, the fastest vessel in the squadron except the Brooklyn, and the Indiana, which formed the most easterly end of the blockading squadron, also opened fire at long range on the Teresa as she came out of the channel. For thirty-five minutes the battle raged fiercely, the whole Spanish fleet in its original order turning line ahead westward, close to the shore; and the American fleet, in its blockading order from west to east, also gradually forming line ahead, with the Brooklyn leading. Fifteen minutes after the action began the Teresa was seen to be on fire. She soon dropped behind and was beached $6\frac{1}{4}$ miles from the harbor entrance. Meanwhile the Vizcaya, Cristobal Colon and Oquendo were gaining on the four battle-ships, and were concentrating their fire on the Brooklyn. Then the Oquendo dropped out of line and was beached half a mile further on than the Teresa, leaving the Colon and Vizcaya with apparently nothing but the Brooklyn to stop them. The Oregon, however, the most easterly vessel but one in the semicircle, proved to be much faster than the Spaniards had anticipated, and, having successively passed the Texas and Iowa, came up within 600 yards of the Brooklyn and kept her position until the battle was over. This must have been about 10.30, when the Oquendo was beached. The Brooklyn and Oregon continued chasing and firing at the Vizcaya and Colon. At 10.53 the Vizcaya was seen to be on fire, and at this time the Colon, previously astern, passed her on the landward side, showing much faster speed for the moment than the Brooklyn. The Vizcaya was turned toward the shore and run aground some minutes later, twenty-one miles from the harbor entrance,

the corrected time at which firing at her ceased being given by Lieut. Sharp, of the Vixen, at 11.18. By this time the Colon, hugging the shore, was six or seven miles ahead of the Brooklyn and Oregon. The Brooklyn at once steered for a point near Cape Cruz, which the Colon must necessarily pass, while the Oregon kept right behind to check any attempt at doubling back. Between 11.18 and 12.50 no shots were fired, but at the latter time the Oregon tried her 13-inch guns and found that they carried beyond the Colon, whose spurt had been short and whose speed had gradually decreased. The Brooklyn then opened with her 8-inch guns, and after both ships had fired four or five rounds the Colon ran ashore and hauled down her flag at 1.20 p. m., being then forty-eight miles from the channel entrance. By this time the Texas and the New York were approaching, though not within range. The New York, Admiral Sampson's flagship, was four miles east of the blockading station when the action began, being on her way to Siboney, where the Admiral was to hold a conference with General Shafter. She at once turned back and was in at the death, without having been able otherwise to render effective aid.

Let us now return to the two torpedo-boat destroyers Pluton and Furor. When they appeared at the channel entrance the Indiana, Oregon, Iowa and Texas, which had all been firing at longer or shorter range at the Spanish armored vessels, with one accord turned their secondary batteries on the destroyers, aided by the converted yacht Gloucester with a battery of 6-pounder guns. The Gloucester exposed herself in the most daring manner to the much superior guns of the destroyers, the armored cruisers and the land batteries. The fate of the destroyers was ultimately determined by the Gloucester and the Indiana, one being sunk and the other being driven ashore totally disabled within twenty minutes after coming into action.

As regards speed, the Spanish ships came through the channel at from 8 to 10 knots, and this was increased as soon as they reached clear water. The Colon, the only ship which had a chance to run away, showed her heels to the Brooklyn and Oregon for a short spurt, but soon fell down again. Admiral Sampson has carefully estimated her speed from start to finish at 13.7 knots an hour. The Brooklyn had only one pair of engines coupled up and could not afford the time to throw in the forward pair; as she gained steam her speed rose gradually from 14 to 16 knots. The battle-ship Oregon also ran up to 16 knots and had plenty of steam long before the others. The Iowa and Indiana were falling behind before the Vizcaya ran ashore, the Texas was gaining on the Colon during the last hour of the chase.

Only one man was killed and one wounded on the United States ships during the whole engagement. Both these casualties occurred on the Brooklyn, which was also struck by twenty whole shot without injury, besides being hit many times by pieces of bursting shell and small shot from machine guns. Two 6-inch projectiles struck the Iowa; one of these lodged in the cofferdam without exploding; the other entered the star-board side at the berth deck, broke off the hatch plate of the water-tank compartment and exploded; perforated the walls of the chain locker, starting a small fire, which was soon extinguished, while one fragment cut a link of the sheet chain wound round the 6-pounder ammunition hoist, and another fragment perforated the cofferdam on the port side and slightly dished the outside plating. The Oregon was struck three

times, and two of these hits were only fragments of shells. The *Indiana* was struck twice without injury, and no hits are mentioned by the *Texas*.

The only ammunition expenditures made public are those of the *Brooklyn* and *Iowa*. The *Brooklyn* fired 100 8-inch, 473 5-inch, 1200 6-pounder and 200 1-pounder. The *Iowa* fired 31 12-inch semi-A. P. shell, with full charges; 35 8-inch common shell with full charges, 251 4-inch R. F. common shell, 1056 6-pounder common shell, and 100 1-pounder common shell. Trouble and delay were caused by the jamming of the locks on the *Brooklyn's* 8-inch guns, and several of the 5-inch guns were rendered useless before the end of the battle by failure of the elevating gear.

Thus far every statement made about the battle of Santiago has been strictly taken from the official accounts of the admiral, commodore or captains. A mail letter by the correspondent of the *Associated Press*, which has intrinsic evidences of truthfulness, gives an account of a visit paid to the Spanish ships by a board of inspection appointed by Admiral Sampson. The first ship examined was the *Cristobal Colon*, which was found to have been struck only six times by large projectiles, *i. e.* over 6-pounder. This tallies with the statement in the official report by Admiral Sampson that "the *Cristobal Colon* was not injured by our fire." However, as we now know that the *Colon* had no turret guns, it would have been madness for her to persist in trying to escape when the *Brooklyn* and *Oregon*, both superior in fire and in speed, were within range and between her and the open sea.

The *Vizcaya*, the next ship examined by the board of inspection, was hit with large projectiles fourteen times, by 6-pounders eleven times and an unknown number of times by 1-pounders. These fourteen shots, between 5-inch and 8-inch, were apparently sufficient to tear the *Vizcaya* almost to shreds above the armor belt. The flagship, *Infanta Maria Teresa*, was the only vessel struck by a 12-inch or 13-inch shell during the engagement. Two projectiles of this calibre struck her, both going clean through the unarmored sides of the ship. There were fourteen guns of either 12-inch or 13-inch calibre in the attacking fleet, but there is good reason to believe that two of these were undergoing repairs and were not fired during the action. It will be remembered that the *Iowa*, which was in action thirty-five minutes, fired thirty-one 12-inch shells. If the other battle-ships used proportionally the same amount—and the *Oregon* and *Texas* were much longer in the action—the total fired would be 108, giving less than 2 per cent. of hits. The most destructive shot which struck the *Teresa* was an 8-inch shell from the *Brooklyn*, discharged at 1000 yards range. This entered the port side, just forward of the beam, and exploding, cleaned out the deck, including four gun crews. Admiral Cervera afterwards said that it was this shell which set the *Teresa* on fire, and as either it or some other projectile had cut the fire main, it was found impossible to put out the fire, which led to the *Teresa's* early surrender. The *Almirante Oquendo* presented the most typical appearance of a ship defeated in a modern naval action. Her upper works were cut into ribbons and the number of dead was very large. She received a good part of the fire of the 6-pounders and 1-pounders intended for the torpedo-boat destroyers which followed her. She was hit on the port side, which was turned toward the attacking fleet, four times by 8-inch shell, three times by 4-inch, twice by 6-inch, and forty-two times by 6-pounders. The attacking fleet, besides 12-inch

and 13-inch guns, had thirty-two 8-inch, fourteen 6-inch, twelve 5-inch rapid-fire, six 4-inch rapid-fire, and seventy-two 6-pounders. To enable the curious to estimate the percentage of hits, the armament of the Brooklyn and Iowa, which gave their expenditure of ammunition, is as follows: Brooklyn, eight 8-inch, twelve 5-inch rapid-fire, twelve 6-pounders and four 1-pounders. The Iowa had four 12-inch, eight 8-inch, six 4-inch rapid-fire, twenty 6-pounders and four 1-pounders.

None of the ships in action used smokeless powder except the Colon, and the fumes of brown cocoa powder were very distressing to the American gunners. Although there was a slight breeze, the clouds of smoke seriously interfered with the aim of the gunners, especially those with the large guns, while the fumes were so choking that many of the gunners had to wrap damp towels over their mouths. Both range-finders and range-indicators were upset and rendered useless by the shocks produced by the firing of the guns. One end of the deck of the Texas was torn to pieces by the shock of one of her two 12-inch guns. The noise of the firing prevented messages from being carried by the speaking tubes, and at least one messenger delivered a wrong message. None of the commanding officers used the conning tower; all of them stood out in the open. Most of these facts have been gleaned from mail letters to the New York *Commercial Advertiser* by an officer on board the Iowa. These letters are corroborated to such an extent by the official reports that they must be regarded as trustworthy.

The first lieutenant of the Vizcaya, in an interview with a correspondent of the New York *Sun* the day after the battle, gave the following reasons for the defeat of the Spanish: "The fire from your guns was terrific; shells were continually striking us at all points, and it seemed as if each shell started a new fire wherever it struck. Our men were driven from their guns by the rain of secondary battery projectiles and by the fire and smoke of burning wood on our ship. In twenty minutes fires had started fore and aft. The decks and the joiner work in the officers' quarters and all along the berth deck took fire, and it was no longer possible to keep our men at their guns."

It is plain from this that the Americans won by bravery, coolness, discipline and drill. It is equally clear that the Spaniards were demoralized by the superiority of the Americans in rapidity and effectiveness of fire. The lesson seems to be that in future naval conflicts a superiority, however slight, in the beginning of an engagement becomes multiplied in its effect on an adversary by something like geometrical ratio, since the moral disorganization produced, by cutting off the return fire, encourages accuracy of aim on the other side as fast as ranges are found by actual trials. This, however, does not settle the question of whether many guns with light crews would be superior, other things being equal, to fewer guns with heavier crews, or with a competent reserve to take the place of men put out of action. Another most important deduction is that shooting in action with high-power guns by no means yet compares in accuracy with practice shooting.—*The Engineer*, Sept. 16, 1898.

THE DESTRUCTION OF THE UNITED STATES BATTLE-SHIP MAINE.

By Lieut.-Colonel J. T. BUCKNILL, late Major R. E.

(Concluded from page 754.)

The evidence concerning the explosion by those who saw and heard it, by the wreck itself, and by an expert in explosions has now been examined, and the readers of these articles will be able to judge for themselves whether the large-mine theory adopted by Captain Converse, and afterwards by the court itself (although they located the charge differently), is correct. For my own part the theory appears to be not only improbable, but quite impossible. Firstly, because any such initial cause of the disaster would have given a tremendous shock and explosion, to which every survivor on board would have testified, whereas only one did so—Lieutenant Hood; for Seaman Larsen "heard some explosion in the port gangway; something like an explosion"; he "just turned round, and then the big explosion came" (page 174). He does not testify to an initial great explosion. Lieutenant Hood, however, was very positive about it (page 119): "There were two distinct explosions—big ones, and they were followed by a number of smaller explosions." He adds (page 123): "My belief is that the whole forward part of the superstructure . . . was in the air at the time I saw the second explosion." This was in answer to a leading question from the judge advocate. Secondly, assuming the finding of the court to be correct, it is quite evident that Lieutenant Hood's surmise might also be correct, because a mine capable of driving the keel into an inverted V 34 feet above its normal position would drive that portion of the vessel locally above it into the air, including the superstructure and the decks below it and the magazines below them. This is, of course, a corollary of the finding of the court. But where does it land us? Evidently, if the magazines were driven into the air by the first great explosion of a great mine under the ship's bottom, the contents of the magazines would explode in the air. There was no such phenomenon. Many people saw the crater of explosion; not one even hints at any explosion in the air.

Moreover, the evidence of the entire wreck gives the most positive and convincing proof that the magazines exploded when they were still *in the ship*, and the evidence of the crew of the steam launch shows that it occurred when the ship was still floating alongside the launch.

Thirdly, had the disaster to the Maine been caused by the explosion of a large mine under her bottom, it can be stated with a good deal of certainty by those who are acquainted with experiments with large charges—such, for instance, as the series of 500 lbs. of gun-cotton against H. M. S. Oberon, and especially the last experiments of this series (early in 1875), that the effects would be very different from those which are recorded by the wreck of the Maine.

The final 500-lb. charge fired against the Oberon, as recorded in the *Times*, was submerged 50 feet, and was directly under the starboard side at frame 18 (a curious coincidence). The vessel's back was broken, but the injuries were not so great as to prevent her being towed into shallow

water after the explosion, and the damage, as recorded by the bent or broken bracket plates and angle irons, was confined to the double bottom and to those portions of the double sides below No. 3 longitudinals. Evidently, therefore, if the force applied were increased either by the use of a larger charge, or of a smaller distance, or both, we should foretell with confidence that the general effect would be—bottom blown up and top sides left nearly intact.

This, moreover, would, I think, be anticipated, even in the absence of any Oberon or similar experiments to guide us, for it is evident that the bottom receives the blow flatways, whereas the sides receive it edgewise. In the *Maine*, however, the sides are gone, and part of the bottom remains. Consequently the sides must have been blown out by the mazzines when still inside the ship, where they could not possibly have been if a large mine acted as an initial explosion in accordance with the finding of the court.

Fourthly. There was no upheaval of water; and a big mine, capable of driving the bottom of the *Maine* 34 feet up without sending it into small fragments, would naturally carry with it much of the water between the mine and that part of the ship's bottom which gave way at the time of the mine's explosion. The fact that there was only 12 feet between the ship's bottom and the mud is in favor of a small water column, but nevertheless of such dimensions that it could not fail to be observed by many of the survivors who gave evidence on the falling débris. Not one drop of rising or falling water, however, was mentioned in the evidence; although it was a point on which the court sought for evidence very diligently. Of course a large mine, exploded in contact with the bottom, would throw up no water; but such a mine would not bend the double bottom, it would shatter it.

Fifthly. A mine capable of bending the keel and double bottom *and* driving them 34 feet upwards would *not* bend them into a sharp angle—as was done at frame 18 of the *Maine*—but would produce a dome-shaped wreckage. The remains of the *Maine* show nothing of the kind.

Other reasons might be given (such as no dead fish floating in the harbor next day, and so forth), but enough has probably been said to raise a grave doubt on the accuracy of the finding of the United States Court of Inquiry. The difficulty was to account satisfactorily for the results of the *Maine* explosion from internal forces alone, and this, no doubt, weighed so strongly with the court (which from its report evidently examined the matter very carefully and honestly) as to cause it to come to the conclusion that the bottom must have been driven up by some external force. The grave objections and contradictions entailed by this finding, which have been pointed out in these articles, do not appear to have been considered by the court, and at the time of the finding it probably seemed to the court a palpable case of a ship blown up by a mine. The perusal of Captain Converse's evidence, however, shows the reader that he was puzzled, and no wonder. He was suddenly shown a most complicated over-water wreck; also a rough sketch of what was said to be under water, and he could scarcely have had time to sift the very diverse evidence on the explosion itself given by the survivors and spectators from a small distance.

The doubt as to the accuracy of the court's finding would become almost a certainty if it be possible to interpret the wreck as the result of internal forces alone.

I feel that this can be done, and beg my readers to patiently examine the following attempt at an explanation which suggested itself after perusing the ingenious theory propounded in a leading article on the subject published in *Engineering* on April 22 last. This theory, that the bottom was bent by the sinking of the fore part of the Maine when the after part was still water-borne, the sides and decks of the midship having been removed by an internal explosion, and "that the after part may have moved after the stem became embedded in the mud," appeared to me to account for the wreckage, whereas the finding of the court did not.

On examining the theory the following difficulties, however, presented themselves:

1. Fourteen feet of water under the bottom of Maine would scarcely give a sufficient scope for the suggested action.

2. Which, moreover, relies on Exhibit H. Expert diver Dwyer, however, disapproved its accuracy. The flaps marked A B on the sketch, instead of being hinged horizontally (as shown), must be hanging on nearly vertical hinges, the fore body lying on the mud on its starboard beam ends ram down, instead of as shown in the sketch.

Nevertheless, this theory was a brilliant and clever conception, and very helpful, as indicating the kind of action which may have produced the wreck, without resorting to the idea of a great submarine mine with its accompanying treachery.

My theory is as follows:

1. That a small initial explosion occurred in or close to the 6-inch reserve magazine—port side—about frame 27 (see Figs. 1 and 2, page 503, *Engineering*, April 22).

2. That the contents of this magazine immediately became involved. N. B.—The contents of this magazine first stated to be only 200 lbs. of saluting powders was afterwards corrected. "The saluting powder not being shown so as to require a new supply or a new requisition, we must have had very much more than 200 lbs." . . . "Could not say even approximately how much was in that magazine" (Lieut. Holman, page 36).

The energy of this explosion would be mainly directed to the lines of least resistance, viz. to the adjoining 10-inch shell-room starboard of it, and to the 6-pounder magazines forward, and to starboard of it. At the same time a tremendous pressure would be exerted upon the longitudinal bulkhead to port which separated it from coal bunker A16.

3. This pressure being increased by the further ignition of parts of the contents of the 10-inch shell-room and of the 6-pounder magazine, it would find a vent, and at the same time involve the 10-inch magazine under the starboard turret, as also the forward 6-inch magazine. The principal weight of the ship at this part of the ship being on the starboard side, if the initial explosion occurred on the port side as suggested, the result would be decks lifted, then port side blown out.

4. Having found these vents, the cumulative explosion which lasted, perhaps 2 seconds, perhaps 3 seconds, and possibly more, and which was so graphically described by one of the survivors—as simply "the roaring of the ship," would be discharged through these vents toward port—driving everything before it to port that previously existed in that part of the ship.

5. The final explosion of the large 10-inch magazine would then occur and drive out everything before it within 50 degrees or 60 degrees of the zenith, but being a slow-burning powder—"brown"—its principal effect

would still be towards the vents already opened, viz. upward and to port, but with sufficient violence to send the débris to the port side of the City of Washington moored 300 feet on the port quarter of the Maine.

The principal discharge of this huge accumulative explosion being to port, and its duration being an appreciable time period, the ship itself in the vicinity of frame 27 was evidently subjected to a very powerful reactionary force; in fact, the ship itself was like a floating rocket—burst near the centre—and driven sideways by reaction to starboard.

When the great final explosion occurred, completing the demolition of the ship's sides, decks, etc., it would also drive the double bottom downwards; but the mud being so close, a reaction or recoil would ensue, tending finally to buckle the bottom upwards, and this would occur at the same moment of time that the wall of water surrounding the crater of explosion fell back to the axis of explosion after the gas pressure had expended itself. Moreover, at this same instant, the after body of the Maine would be subjected to a water pressure on its immersed cross-section tending to drive the after body forward—but I take it that this force would be small in comparison to the reactionary force to starboard due to the explosion itself during its accumulation of pressure. Whether so or not, there were evidently several important forces, one tending to drive the after body forward; another tending to drive the whole ship to starboard, and to rupture her at its point of application; and another tending to buckle the ship's bottom upwards. At the same instant of time the bow chain by which the vessel was singly moored is strained to port.

Evidently these forces would tend to bring about precisely what is now known about the wreck. The bow "sunk like a shot" one witness said, and the momentum of the ship to starboard would bring the fore body into the position described by the professional divers. The simultaneous motion of the after body to forward and to starboard would crumple and twist that portion of the double bottom still remaining in such a manner as not only to twist the bent keel at frame 18 in the manner of a knuckle joint, but also to account for the longitudinal corrugations in the inner skin of the double bottom noted by ship's diver Olsen.

There is nothing in the least degree improbable in the above theory of the Maine disaster, and it agrees with the wreck, which, after all, is the most important and reliable witness. It is based principally on the reaction caused by the explosion itself to starboard horizontally during the whole time of the "roaring," also to the reaction from the muddy bottom from the final great explosion. It takes into consideration the bow chain and the inrush of water (with its floating bodies) to fill the crater of explosion.

The proximate cause of the explosion may never be known. If due to any neglect the culprit may be dead; and if he still live he would naturally take considerable care to let it remain unknown. For my own part I think it was due to coal heating in bunker A16, which was what is known as a "difficult bunker," i. e. one that it was not easy to fill or empty. It was full of soft coal "Pocahontas" (page 152), 40 tons, and had been so for some time. There was evidently some fear as to coal heating in the bunkers, although nothing of the kind had occurred in the Maine. Her bunkers were fitted with "the usual thermostats" (page 154), but "they did not work very well. Sometimes they rang when there was no coal in the bunker." The United States' practice appears to be different

from H. M. navy as regards the lining of magazines. An officer of H. M. fleet, high in command, informs me that "the powder magazines in our service are always lined with wood, so that the powder cases can never touch the steel or iron bulkheads—whether the adjoining compartment is or is not a coal bunker. As a rule, the magazines are not next to the coal bunkers—indeed, it is quite the exception if they are." The evidence on the *Maine* showed that a powder tank in the 6-inch reserve magazine lay against the steel bulkhead, metal to metal. In fact, there were only two thicknesses of this metal in contact between the soft coal and the saluting gunpowder, and this although it was considered necessary to equip the coal bunkers with thermostats. Comment is unnecessary.

Again, as regards rockets, which have ever been such a fruitful source of explosions, Lieutenant Holman was asked (page 141) to "state where rockets and blue lights and such things were stowed on board the *Maine*," and replied, "In the chart-house or the pilot-house upon the bridge."

Q. "All of them?"

A. "All of them, I think. I do not know of any having been moved from there. They were stowed there originally, and I know of no move having been made."

No other witness was asked about the rockets. On the whole there seems to be no necessity for going outside the ship to account for the primal explosion.

Of course it may have been due to a small contact charge, but the only evidence in favor of it is a "cock and bull" story in an anonymous letter, which was treated by the court with the silent contempt it deserved.

It therefore seems to the writer that Americans should dismiss from their minds the idea that the *Maine* was blown up by the Spanish authorities, or with their cognizance—all the evidence pointing entirely in the other direction, viz. that the disaster was purely accidental, and that the explosions were confined to the interior of the ship.

APPENDIX.

The contents of the forward magazines were as follow: Forward magazine—99 full charges, 6-inch B. L. R.; 164 reduced charges, 6-inch B. L. R.; 146 common shell, 6-inch B. L. R.; 100 armor-piercing shells, 6-inch B. L. R.; 24 shrapnel, 6-inch B. L. R. Forward fixed ammunition-room—1672 rounds, 6-pounder steel shell; 1232 rounds, 6-pounder common shell; 297 rounds, 6-pounder blank; 1020 rounds, 1-pounder steel shell; 660 rounds, 1-pounder common shell; 10,000 rounds, ball cartridges, 6 millimetres; 9000 rounds, ball cartridges, .38 millimetres. Forward 10-inch shell-room—90 common shell, 10-inch B. L. R.; 74 armor-piercing, 10-inch B. L. R.. Forward 10-inch magazine—92 full charges, per 10-inch B. L. R.; 88 reduced charges, per 10-inch B. L. R. Reserve magazines—113 full charges, per 6-inch B. L. R.; 51 reduced charges, per 6-inch B. L. R.; 3400 rounds spare saluting powder in tanks; 100 lbs. shrapnel and impulse powder.

But Captain Wainwright (page 270) testified to the recovery, by divers, of 35 powder tanks, 6-inch, and 10 powder tanks, 10-inch, and that powder was found in two of them . . . showing that the whole of the above contents of the forward magazines could not have exploded—that a certain portion escaped ignition.—*Engineering*.

THE DESTRUCTION OF THE UNITED STATES BATTLE-SHIP MAINE.

To the Editor of Engineering.

Sir.—Like all other Americans, I have taken great interest in the causes of the Maine disaster, and have read all the official documents and many private essays on the subject. In Europe I have observed a tendency on the part of most writers to become so fascinated with the problem of how the explosion *might* have occurred from internal causes, that it ends in their losing entire sight of the simpler theory of an external explosion, which they seem to think is necessarily an accusation of complicity on the part of the Spanish government.

There has lately appeared in *Le Yacht* an able article by "V. G." Later, an exhaustive paper by Captain Gereke in the *Marine Rundschau*, both to the same effect; and last, ablest and most prejudiced of all, is the article by Colonel Bucknill, which is concluded in your issue of June 24, and which I have just received.

The colonel's reasoning as to the successive developments and effects of the explosion after it had once commenced is excellent; but in the early part of his article he assumes the planting of a torpedo to be a matter of entirely too much difficulty and publicity; and in his conclusions as to the cause (being in his opinion that of spontaneous combustion in bunker 16), he is eminently unfair in quoting only such evidence as will support his contention. He states that there was soft coal in this bunker "which had been there for some time," and that "the thermostats did not work very well," and that there was evidently some fear as to coal heating in the bunkers, as though this were a unique experience on board ship; but he ignores the statement (page 280) that this bunker was accessible on three sides at all times, and at this particular time on the fourth side, and that it had been inspected that very day by the engineer officer on duty. The colonel quotes the evidence of a gunner, who had been relieved from duty some time before and who, apparently judging from his other evidence, was incompetent, to show that the tanks in the reserve magazine touched the metal bulkheads, while he ignores the statement of the captain to the contrary. He also brings in the opinion of an officer "high in command" in the English navy as to how English magazines are lined and located, and is correspondingly sarcastic on what he assumes to be American methods of lining—or rather not lining—and locating magazines. As a matter of fact, the naval constructors of all nations are perfectly familiar with each other's practice in this respect, and wherever weight and danger of fire can be eased by reducing solid wooden linings to chocks and battens it is done, and the location of the magazines and shell-rooms is nowadays always dependent upon the disposition of the battery. He also ignores the fact that the temperature of coal bunkers and magazines were taken every day, and calmly assumes the temperature of 500 degrees Fahr., which would be necessary to ignite powder to be reached without anybody knowing anything about it. Let any one who has stood watch in a fireroom with the thermometer at only 150 degrees give his opinion.

Some time ago I wrote Commander Kimball, United States Navy, who is now commanding officer of our torpedo-boat flotilla on the Cuban

coast, and one of our ablest torpedo experts, and among other things I asked him about the Maine affair. In his reply he says: "She was probably blown up by an improvised torpedo, planted just ahead of her, and fired when she swung over it." It appears to me that we have the whole matter here in a nutshell. Twenty-five years ago, at the torpedo station at Newport, R. I., one of the frequent exercises of the officers under instruction was the construction of improvised torpedoes. The operation consisted simply in taking an empty powder or fish keg, pitching it inside and out, filling it with gunpowder, inserting an electric igniter through a cork in the bung, lashing a stone to it, and putting the whole in a skiff pulled by two men, carrying it out a couple of hundred yards, heaving it overboard, running the wires ashore and firing it off. The whole operation occupied from two to three hours. Sometimes English lead-covered tape fuze (of which there were some miles at the torpedo station) was used; this tape had been taken from Southern harbors, where it had lain for years under water in the Confederate mine system. It was usually found to be still good, and saved the wear and tear of electric apparatus.

In Havana, as in most other frequented harbors, there are always scavenger boats going about, especially in the vicinity of men-of-war, searching the bottom with tugs and drag nets, and a torpedo of this kind could have been planted in broad daylight by such a boat a day or a week before it was exploded. It could have been brought into direct contact with the ship's bottom by giving a few feet drift to the mooring line, for gunpowder, having only the specific gravity of rice, floats easily. The quantity of powder would have been ample, especially if the operator had had the wit to put four or five igniters in it instead of one, and thus brought about detonation instead of explosion. The first shock to the ship would have been given by this torpedo, but no outward commotion of the water would have been caused, because the line of least resistance was through the bottom of the ship, and it would have driven pieces of the bottom plating into the magazines or shell-rooms with sufficient velocity to have set off the fixed ammunition at least, and probably large filled shell, as experience has shown, especially during the Japan-China war, that this can easily be done by impact; the interior explosion once initiated, the sides of the ship would go out, the deck would go up with flame and débris and the reaction from the bottom would bend the keel.

The motive which impelled the blowing-up of the Maine is a matter that should neither enter into the discussion of the cause and the phenomena, nor cause a bias in either direction.—F. M. BARBER.

TEST OF A SIX-INCH EXPERIMENTAL KRUPP PLATE.

Our naval authorities are to be congratulated on their broad-mindedness and enterprise in adopting a foreign process of armor-plate manufacture which has easily proved itself to be the very best in the world. The Krupp gas process has produced plates which are as superior to the Harvey and Corey plates as the latter plates were to the all-steel and compound plates of an earlier day. Its superiority, as shown by proving-ground tests, was so marked that the English Admiralty at once adopted

it in place of the Harveyized armor, and it is now being placed upon all the newer vessels of their navy; and after the very excellent results obtained at the Indian Head Proving Ground it was inevitable that the new armor should be chosen for all our future ships.

The supreme value of the ever-increasing hardness and toughness which is being given to armor plates consists in the fact that the new plates enable the total weight of armor with which a ship is clothed to be greatly reduced, and the weight so saved may be appropriated to a more powerful armament, or engines and boilers of greater horse-power. Proving-ground tests and experience in actual warfare have shown that the protection afforded by the 15 and 18-inch Harveyized armor of the Oregon is amply sufficient to resist modern high-powered rifles. Although the 18-inch belt or 15-inch turrets of the Oregon type of ship have never been penetrated in an actual engagement, the behavior of inferior heavy armor at the Yalu and at Santiago proves that the heavy Harveyized protection of our ships renders them practically impregnable against shell fired from the distances at which modern engagements will probably be carried on. This being the case, it follows that every improvement in the quality of the later armor enables us, taking the protection of the Oregon as a standard, to make a corresponding reduction in the thickness of the plates.

The improvements introduced under the Corey patents made it possible to increase the tensile strength about 12 per cent. and the elongation about 15 per cent. over that of the Harvey plates; and now the Krupp gas process enables us to produce a plate of such wonderful toughness and hardness that armor 10 and 11 inches in thickness has all the powers of resistance shown by the 15 to 18-inch armor of the earlier vessels.

The Krupp gas process is the latest development in a long line of experiments which has successively provided the world with iron, compound iron and steel, all steel, Harveyized steel, nickel steel, Harveyized nickel steel, reformed Harveyized nickel steel, and Krupp steel. The rights have been purchased in this country by the Carnegie Company, and the second experimental plate recently tested at Indian Head proved to be of exceptionally high quality, even for a Krupp plate. Krupp armor shows remarkable toughness combined with all the hardness of the best face-hardened armor, and, unlike armor manufactured by other well-known processes, the Krupp product maintains these qualities in the very thickest armor.

The plate tested at Indian Head measured 5 feet 8 inches by 9 feet by 6 inches. The backing consisted of 12-inch oak and two $\frac{3}{4}$ -inch skin plates secured to the plate by ten armor bolts. The plate and backing were secured to the normal target structure by four holding-in bolts 1.5 inches in diameter which passed through the backing, and by four similar bolts secured to the exposed vertical edge of the backing. The plate has a good surface and general appearance and was hard to a depth varying from 1.5 inches to 2 inches. The plate was so secured that "top" was the right vertical edge.

First round.—The gun used was 6-inch rapid-fire. The charge of powder was 22.25 pounds of Dupont's S. P. F. G. 3; the striking velocity, by chronograph, was 2021 foot-seconds and the striking energy 2831 foot-tons. The projectile used was a 6-inch armor-piercing Carpenter, hardened to 3 inches below the bourrelet, without cap; weight, 100 pounds. The impact was at a point 39 inches from the bottom of the plate, 58.5

inches from the left edge and normal to the surface. The projectile smashed on the plate, only a small part of the point remaining welded in the plate, a large part of the body and base of the projectile being found in one piece in front of the plate. The estimated penetration was 2.5 inches. A back bulge 1.5 inches high was formed on the rear of the plate. The plate was dished in the vicinity of the impact $\frac{1}{4}$ inch. The impact on the surface of the plate covered an area 12 inches in diameter. The plate was not cracked, nor was any injury done to the backing bolts, or structure.

Second round.—The same gun, 6-inch, was used. The charge of powder was 25.8 pounds of Dupont's S. P. F. G. 1. The striking velocity was, by chronograph, 2237 foot-seconds and the striking energy was 3469 foot-tons. The projectile used was a 6-inch armor-piercing Carpenter hardened to $2\frac{1}{2}$ inches below the bourrelet, without cap, weight 100 pounds. The impact was at a point 19.4 inches from the bottom of the plate, 92 inches from the left edge, 39.5 inches from the previous impact, and normal to the surface. The projectile smashed on the plate. A large part of the projectile remained welded to the plate, judging from the smaller part of body and base found in front of the plate. The estimated penetration was 5 inches. A back bulge 4.5 inches high was formed on the rear of the plate. The plate was dished $\frac{1}{8}$ inch in the vicinity of the impact. The impact on the surface of the plate covered an area 10.5 inches in diameter. The flaking extended around the impact to a diameter of 16.5 inches. The plate was not cracked, nor was injury done to the backing, bolts or structure.

Third round.—The same gun, 6-inch, was used. The charge of powder was 25 pounds of California S. P. perforated cylinder. The striking velocity was, by chronograph, 2350 foot-seconds and the striking energy 3828 foot-tons. The projectile used was a Carpenter 6-inch armor-piercer without cap, hardened to $2\frac{3}{4}$ inches below the bourrelet; weight 100 pounds. The impact was at a point 20.25 inches from the bottom of the plate, 21.5 inches from the left edge, 41 inches from the nearest previous impact, and normal to the surface.

The projectile perforated the plate and broke up all parts, going through the plate and the oak backing; but they were stopped by the skin plating without cracking the latter. The hole made in the plate was of an irregular oblong form, having greatest diameter of 8.5 inches at front and rear and no spur. A part of the plate of the same shape as the hole was driven ahead of the projectile in one piece, as though punched by a powerful punch. The plate was dished 0.3 inch in the vicinity of the impact. The flaking on the front face was 17.5 inches in diameter. The plate was not cracked, nor was any further injury done than set forth above to the plate, backing, bolts or structure.

Fourth round.—The same gun, 6-inch, was used. The charge was 32.3 pounds of Dupont's S. P. F. G. 3. The striking velocity was, by chronograph, 1984 foot-seconds and the striking energy 2837 foot-tons. The projectile used was Carpenter 6-inch A. P., fitted with standard cap, hardened to 4 inches below the bourrelet, weight 104 pounds. The impact was at a point 18.25 inches from the bottom of the plate, 9.5 inches from the left edge, 21.25 inches from the nearest previous impact, and normal to the surface. The projectile perforated the plate and broke up, all parts going through the plate, backing and skin plates, and barely entering the sand butt in the immediate rear of the structure. As in the

previous round, the hole made was oblong in shape, with the greatest diameter of 6.75 inches, and practically the same on the front and rear faces. A spur 1.6 inch high was raised about the point of exit. There was no dish in the plate observable about the point of impact. The flaking on the front of the plate was 12 inches in diameter. No other injury than that noted above was done to the plate, bolts, backing or structure. This plate showed great resisting power. The notable features were the extreme toughness of the back of the plate and great thickness of the hard face, the comparatively small flaking on the front face, and the entire absence of coning on exit at the rear. The plate was of good appearance as regards surface, both front and rear.

Continued improvement in quality, peculiar to the American manufacturer, will no doubt result in the near future in armor plate manufactured by this process, and the result will no doubt be equally as superior to that manufactured in Europe as is our present ordinary face-hardened armor.—*Scientific American*, Aug. 27, 1898.

A DEFENCE OF THE TORPEDO-BOAT.

The *New York Times* quotes a naval authority as follows on the value of the torpedo-boat:

"Commodore Hichborn does not seem to think that the torpedo-boat will play much part in future naval warfare. I do not agree with him, and his own article upon the subject affords sufficient ground for this disagreement on my part. He says, after condemning the torpedo-boat and saying that during the war it was practically of no use at all, that 'these boats were not used by either combatant except occasionally for dispatch boats, a duty to which other craft might be more advantageously assigned.' If they were not used properly, I do not see how the Commodore can argue therefrom that the war has disproved their claim to usefulness.

"He also says that the converted yacht Gloucester defeated both the *Furor* and *Pluton*, 'among the very best and most modern of the destroyer class.' I don't think that even this result, creditable as it is to our Navy and the gallant men who fought the Gloucester, is at all decisive. There are many things to be considered before we give up these brave little craft, which I am confident are fully equal to the task we have assigned to them.

"We used the torpedo-boats as dispatch boats, and even sent the Winslow into Cardenas harbor to reconnoiter. Such duties should never be given to these craft. Nor should they be subjected to the heavy fire from battle-ships until they are brought under cover to easy striking distance, and then only for the brief period of time in which they are speeding like a bolt toward their victims.

"The Gloucester did defeat the two destroyers at Santiago, but it was under peculiar circumstances. As they came out of the harbor they were fairly swamped by a rain of shell and small shot from the other ships, and besides, they were not protected, but had to make their way toward the foe in an open sea. It would have been a miracle if they had ever got within striking distance of any of our ships.

"The same thing is true of the torpedo-boats that attempted to attack Dewey in Manila Bay. They could not have protection of any kind and

made a bold dash in the open sea at the Olympia. It was in both cases a tempting of Providence and an act of mere bravado or desperation. No careful fighter would have risked these boats in that way, except in such terrible straits that it might be better to go down facing the foe than to surrender or sink his own vessels.

"Great injustice has been done these boats. Although known not to be shot-proof, they have been run into heavy fire. The only result of the war, so far as the torpedo-boat and the torpedo-boat destroyer are concerned, is that we have not yet learned to fight these vessels properly. With all their defensive power sacrificed to speed and the handling of explosives, they had a right to be protected while being advanced to attack. Instead of this, they were pushed forward, fully exposed, to meet certain ruin.

"The lessons we should have learned are: 1, That the torpedo-boats should never be used for making reconnoiters, as we used the Winslow in Cardenas harbor; and, 2, that, when taken into action with battle-ships to attack battle-ships and cruisers of the enemy, they should be kept under the shelter of the big ships. One could go behind each of the great vessels until the proper time came and the proper distance was reached for a dash at the foe. They should then rush out from behind the battle-ship, make a dash for the enemy, discharge their explosives, and return to cover at once. This protection of the weak by the strong was resorted to successfully by Admiral Farragut in his passage of the batteries of Mobile Bay, August 5, 1864. It is the only principle of fighting these small unprotected craft, which must yet be got to close quarters before they can deliver their blow.

"I agree with Commodore Hichborn in the statement that the big battle-ship must still be the main reliance in battle, and that we shall evolve ships that will be greater Oregons, with more speed, greater radius, and greater fighting power; but the torpedo-boat and the destroyer will, I believe, remain as a permanent feature of modern sea fighting. The use of explosives is one of the most striking characteristics of warfare as conducted in the present day. We employed dynamite guns in the field in Cuba, we are using, with fairly good results, a dynamite cruiser, and we are experimenting with boats that will steam under the waves for the sole purpose of exploding torpedoes under battle-ships.

"I consider the torpedo-boat as a step in this line of development. Its small size, its great speed, its inconspicuousness should serve to make it a terrible instrument of destruction. It is admittedly so, provided it can get within range, and it is the duty of the admiral to protect it so with his large boats as to permit it to come up under cover and deliver its fearful thunder right against the side of the great battle-ships. In the midst of a hotly-contested battle I believe it would be a comparatively easy thing for torpedo-boats to rush up to the big men-of-war unnoticed until too late to stop them.

"I notice that in the navies of Europe they are not only building more torpedo craft—both the torpedo-boat and the destroyer—but they are now building a destroyer of the destroyer. This shows how much feared these boats are. It also shows that the development is along lines of speed, connected with destructive power. But we cannot have great speed coupled with great defensive or destructive power, hence we must have the speed of the torpedo-boat for launching great instruments of destruction like torpedoes. In battle and under cover of darkness the torpedo-

boat would be able to inflict the most terrible damage upon a fleet. Of course we cannot fight them against battle-ships in open sea. To do so means that they will be destroyed, as at Manila and Santiago, under a storm of shot and shell from the rapid-fire guns.

"I fancy, too, that had Americans or Japanese or Englishmen been in the *Pluton* and *Furor*, and watched their opportunity for mischief, and been bold enough then to carry out their purpose, we should have a different story to write about the result. The Spaniards have never had a victory on the sea."

The American Navy of the future, if the ideas that now prevail in the Navy Department remain in the ascendant, will have an abundance of these small craft. The result at Santiago has not yet destroyed the confidence that naval experts repose in these wasps of the ocean.—*Iron Age*.

VICKERS' QUICK-FIRE FIELD GUN.

On Thursday, July 21st, Messrs. Vickers invited a number of artillery officers and other visitors to witness the performance of their quick-fire field gun at Eynsford. The idea sprang from the recent discussion in the United Service Institution, there being a strong wish to see what could be effected with the latest improvements. The gun discharges a 6-kilo. projectile—being, in fact, a 12-pounder—so that it illustrates what can be done with a full-sized field gun, not the piece of diminished weight that is the natural proposal to avoid the difficulties of recoil. The carriage had placed along under its trail a strong spiral spring and cylinder, terminating beneath the trail eye in a spade with a blade about 8 inches long and 18 inches wide. The front end of the spiral spring connection was attached to the body of the carriage; the cylinder and spade end was held by two chains, one on each side, to a point half-way along the trail. On firing, the carriage ran back, closing the spring, the trail running back over the top of the spade and cylinder end for about 3 feet, when the spring effected the recovery, bringing the carriage forward again. When forced back by recoil the chains become quite loose, and then attachment is not so rigid as to prevent the trail being moved some distance right and left from the true line of the spring and cylinder. The spade after a time had worked a hole in the ground about 1 foot long and 2 feet broad. The ground was good turf and favorable. Judging from the tracks made by the wheels, the right wheel moved smoothly, while for some reason the left wheel jumped to some extent.

We have mentioned the important matter of recoil first, because its control is the essence of the question. It may be seen that 3 feet is sufficient recoil to make the condition very different from those of naval or garrison pieces on fixed mountings. It cannot, indeed, be said that the gun was brought back truly pointed as in the previous round, nor did the layer attempt to keep his eye to the sights. On the other hand, he performed the firing, the lanyard placing him at a sufficient distance to prevent being struck by the recoil. The piece was, however, laid with great rapidity and accuracy, as may be seen from the following figures:

(1) Four rounds of case were fired; the visiting officers from Woolwich took the time, which was $13\frac{1}{4}$ seconds. The ammunition was all fixed in metal cartridge cases and fired by percussion.

(2) Eight rounds were fired with common shell and percussion fuses. The time from the first to the last report—that is, the time taken in firing seven rounds—was 44.4 seconds. The target fired at was 22 feet by 12 feet, at 1000 yards' range. On this five out of eight rounds were well planted; one shell was premature and one low.

(3) Six rounds were next fired with shrapnel and time fuses, the fuses having been already set. These were got off in 27 seconds, with excellent effect.

(4) The gun at the visitors' request was now trained 45 degrees off the true direction, and the target sight was run down, and the fuse set at zero, so that every operation had to be performed afresh. One round was got off well in 10½ seconds, making a hit.

(5) Four rounds were next fired with shrapnel, starting with target sight set wrong and gun not laid on the target. In 24 seconds after the word to fire the last round was got off, and all four appeared to give admirable results, all delivering their bullets on the upper half of the target.

For this practice ballistite was used in preference to cordite. The shrapnel shell contains 300 bullets, making up a 15-lb. projectile, and the muzzle velocity is about 1800 foot-seconds. When the fuses were supplied set the gun was worked by two men, with a little assistance from a third. To set the shrapnel fuses an additional man is required. The question is, then, How does the above fulfil the conditions necessary to success in a field quick-firing gun?

It may be seen that there is, as already said, no flinching from a full-sized gun and full weight of projectile. On the other hand, the recoil is not so controlled that the layer was able to keep his eye on the line of sight, and another plan was followed by which the piece was well and quickly laid; but it is to be noted that the conditions were all well known, were favorable, and the layer a man of exceptional skill and activity. It would have been possible for an awkward man to have been injured in attempting what this man did. Again, fixed ammunition with a metal case was used, by which loading and firing are rendered more quick and simple; but this involves the complication and trouble which it is our present effort to avoid. The success achieved was undoubtedly remarkable, however, and shows how much may be effected under favorable circumstances without securing all the special elements which we think desirable. The good effect of the shrapnel especially deserves notice. The weight of gun carriage and forty rounds was 30 cwt.

A mountain gun was afterwards exhibited, firing a 6-kilo. projectile, with a muzzle velocity of about 1000 foot-seconds. The heaviest weight for the mule is 230 lbs. The piece was mounted for action by four men in 47¼ seconds, and dismounted in 28 seconds.

A small 37-mm. piece discharged twenty-three rounds in 5.5 seconds, delivering them on the target without loss of direction.—*The Engineer*, July 29, 1898.

THE EROSION OF GUN TUBES.

*On the Action of the Projectile and of the Explosives on the Tubes of Steel Guns.**

By Professor W. C. ROBERTS-AUSTEN, C. B., D. C. L., F. R. S.
(Vice-President).

This important subject has already been discussed by the Iron and Steel Institute. In 1886 the results of some elaborate experiments, conducted by Sir F. Abel and Colonel Maitland† at the Royal Arsenal, led to the conclusion that in a breech-loading gun scoring is produced by the rush of the products of the explosion behind and over the shot, which acts as an air-tight plug passing through the gun. The authors of the paper to which reference has just been made considered that as regards the relative wear of different samples of steel, chemical composition was of far less importance than the mechanical treatment to which the steel had been subjected; and it appeared that the more the steel had been worked and forged, the less it suffered from the effects of the products of the explosion. The average pressure of gas measured in the powder chamber was about 13 tons per square inch, and it was stated that the pressure would be maintained with little diminution during the passage of the shot up to the muzzle of the gun.

All who have conducted experiments with modern artillery know how deeply the rifled bores of guns become scored and eroded during use. It has been stated that the surfaces of the bores of guns also become hardened, even after five "proof" rounds have been fired. An examination of the bores of such eroded guns by the aid of micro-photography should lead to interesting results, and by the kindness of Sir Benjamin Baker the author has been able to obtain a suitable subject for investigation. It consists of a section of the "A" tube of a 4.7-inch quick-firing gun, cut at a point 167 inches from the muzzle. The total thrust between the driving face of the grooves and the driving copper ring of the projectile at this portion of the bore would be about 12 tons. It may be added that, as Sir Andrew Noble has shown,‡ in such a gun as ordinarily employed there would be no less than 60 foot-tons of energy absorbed in producing rotation of the projectile.

The author is also greatly indebted to Lieut.-Colonel C. F. Hadden, R. A., chief inspector of the Ordnance Department at the Royal Arsenal, Woolwich, for a portion of a 3-inch steel armor plate which a "glancing" shot had struck, producing an indentation 0.5 inch deep, 5.1 inches long, partly by compressing the metal and causing it to flow, and partly by tearing portions of metal from the surface of the plate. This indent was produced by an ordinary 6-pounder hardened armor-piercing projectile, and the velocity at the point of impact was 1740 feet per second, and the striking energy would therefore be 126.7 foot-tons.

* Paper read before the Iron and Steel Institute, Stockholm Meeting. His Majesty the King of Sweden and Norway intimated that it was his pleasure to be present during the reading of this paper. Professor Roberts-Austen gave a brief account of the work, and of the researches which had led up to it, dealing only with the main points of the paper itself.

† Journal of the Iron and Steel Institute, No. II., 1886, page 465.

‡ Royal Society Proceedings, vol. 1, 1892, page 409.

As regards the action which might be anticipated to occur during the erosion of an "A" tube, the following facts must be remembered: The temperature produced by the explosion of cordite, which was the propellant employed in the case of the tube in question, would be very high. The heat transmitted to the surface of the tube would, however, soon be abstracted by the mass of metal in the gun. This rapid heating of the interior of the tube, followed by more or less rapid chilling by this transmission of the heat, might therefore be expected to occur. Hence there are possibilities of more or less elaborate changes due to the thermal disturbance caused by merely firing the gun. The mechanical effect of the projectile passing along the tube has also to be considered, and the results should prove to be of interest, as the effect of work in producing molecular change in steel has long been a subject of study by Osmond, Barus, Carus Wilson, and others. The explosion produced by cordite would produce in this gun so high a pressure as 15 tons on the square inch. The problem, therefore, becomes a complicated one, which micrographic examination should render it possible to readily elucidate. First as regards the composition of the steel. The tube was a perfectly normal gun-steel, containing about 0.3 per cent. of carbon and 0.6 per cent. of manganese. The respective amounts of sulphur and of phosphorus did not exceed 0.05 per cent., and the amount of silicon was not more than 0.15 per cent. As regards treatment, the tube had been oil-quenched from a temperature of about 800 degrees Cent., and subsequently annealed to about 500 degrees Cent. Examination with any degree of magnification exceeding 100 diameters, of a new tube in which no charge had been fired, should reveal more or less confused pearlite, produced by the annealing, traversed by bands or a network of ferrite. The transition forms of the carbide, troostite or sorbite, might be present, but there should be no martensite. This proves to be the case in all microsections cut from the mass of the tube. If, however, a microsection be taken either from the extreme edge of a "land," or from the driving edge of a groove, a very different structure is revealed. Such examination demands special preparation of the microsection, as only the extreme edge of the "land" is changed, sometimes only to a depth of $\frac{1}{100}$ inch. It is necessary, therefore, to imbed the metal in a piece of steel of similar carburization and hardness, and to polish the whole. This protects the edge of the metal, which is of interest, from being rounded during polishing, and as the whole of the microsection remains flat, it is possible to focus all parts of it in the same plane. The result of a thorough examination proves that the action of the explosive has, so far as the mass of the tube is concerned, been purely mechanical. The particles of steel have been simply eroded, and there is no evidence of fusion or of the formation of martensite. But at the extreme edge of the "land," or on the driving edge of the groove, both of which have been in direct contact with the driving bands of the projectile, and have been pressed by them, there is an altered layer, often only $\frac{1}{100}$ inch deep, which has been profoundly altered. The most noteworthy feature is that the ferrite bands seldom pass into this altered layer; they either stop short or fade away as they approach the altered edge. As regards the nature of this band which forms the altered edge, it is difficult to speak with certainty, but in some cases it seems to be a confused mixture of carbides. If the steel had been superficially changed into ordinary hardened steel, the altered layer would, of course, consist of martensite, but the presence of frankly developed martensite could not be detected. This suggests the question whether suffi-

cient time elapsed while the metal was undergoing change for the complete diffusion of the carbon in the layer. So far as is at present known, the formation of martensite would demand this complete diffusion of the carbon. It is even possible that the layer may be a deposited one, composed of the detritus of the eroded matter. Against this view there is the fact that in some cases the ferrite bands fade away as the altered layer is approached. In other cases fine lines of ferrite pass into the altered layer. My friend M. Osmond (of whose counsel I have gladly availed myself) considers that, in a matter of so much importance, it would be unwise to express a definite opinion at present.

I have elsewhere* shown that when a projectile strikes an armor plate it may, under certain conditions, produce in the solid steel a "splash" which resembles that produced by a sphere falling into water. I have also† shown that the penetration or carbon into iron obeys the ordinary law of diffusion of salts into water.

It is noteworthy that the surfaces of the "lands" over which the projectile has passed are traversed by cracks at right angles to the length of the "lands."

With reference to the armor plate struck by a glancing shot, to which reference has been made, I do not find that the micro-structure of the armor plate has been altered by the impact.

The paper was illustrated by a series of micro-photographs, carefully prepared by Mr. W. H. Merrett, and by wall diagrams.

THE RUSSIAN NAVY.

The torpedo-boat destroyer which Messrs. Laird Brothers, of Birkenhead, are to build for the Russian navy is to have a speed of 30 knots, and will resemble those constructed for the British navy. A naval correspondent now in Russia has forwarded some of the details of designs of several of the vessels to be laid down by the Russian government, and these are specially interesting, as our government will require to design ships to beat them. The six 23-knot cruisers will be of 6000 tons displacement, their length being 399 feet 3 inches, their beam 52 feet 10 inches, and their draught of water 20 feet. They will have twin screws, each driven by engines of 9000 indicated horse-power, so that the power will be equal to 3 to 1 ton of displacement, which is exceptionally high for vessels of this size. The radius of action, however, will be low, 5000 miles at 10 knots, and the armament and ammunition will fall far short of our vessels of the same class. There will be two 6-inch guns, twelve 3-inch guns, and six smaller weapons. For commerce destruction these cruisers may be effective, but they will have to run away from the foe; in fact, everything has been forfeited for speed. Russia is also going to have four 25-knot vessels for the same purpose, and here also the armament is insignificant, consisting of six 4.7-inch and six 1.8-inch guns. The vessels will be of 3000 tons displacement, the length being 385 feet, their beam 40 feet, and their draught 16 feet. The horse-power will be 17,000 indicated, equal to over $5\frac{1}{2}$ indicated horse-power per ton of dis-

* British Association, Discourse. Toronto, 1897. The Times, August 23, 1897.

† Journal of the Iron and Steel Institute, No. I., 1896, page 139.

placement. Schichan, of Elbing, is laying down one of these vessels at once, and the four others to be built in Russia may be delayed, so that the experience gained with this vessel may be utilized before the others are actually finished. The vessel to be built by the Vulcan Company of Stettin is to have 6250 tons displacement, and she will have 20,000 indicated horse-power. She has thus more power in reserve than the others. The Germania Company at Kiel, which is practically Krupp's, has also adopted the same size and power as the Stettin firm. Germany has altogether three of the new cruisers and four 27-knot torpedo-boats, the United States one cruiser, and the other cruisers may be built in Russia. The battle-ships have not all been given out, and Britain might secure some share if all goes well in the East, and if the workmen in our ship-building yards would be reasonable. It is no new story that thus far British builders have failed only because of the thoughtless attitude of the workers making the Russian government doubtful as to the date of delivery.

The Nevsky shipbuilding yard has received an order for 12 torpedo-boat destroyers, each of about 350 tons displacement, of the type of the Japanese boats built by Yarrow. These works have already in hand ten Sokols, and two more vessels of the same type built at Abo, Finland, are almost ready. The Russian Admiralty has decided to supersede the present Du Temple boilers in all their first-class torpedo-boats by Yarrow boilers. It is also worthy of note that the battle-ship and cruiser ordered by Russia from Messrs. Cramp, of Philadelphia, will have water-tube boilers of the Niklausse type, whereas all the recent ships have Belleville boilers.—*United Service Gazette*, Oct. 1, 1898.

WIRE-WOUND GUNS.

The first wire-wound gun ordered by the United States is expected to be delivered at the proving ground at Sandy Hook, New York harbor, some time during this month. This gun, says a writer in *Cassier's Magazine*, will be of 10 inches bore, 45 calibres in length, and will weigh 30 tons. The contract specifies a normal initial velocity of 2600 feet per second, or 300 feet per second more than that required for any hooped gun now in the United States service. Mr. J. H. Brown, the inventor of this type of gun, is confident that it will stand a charge sufficient to raise the muzzle velocity to 2988 feet per second without material injury to its structure. From official experiments already made at the Sandy Hook proving grounds with an experimental 5-inch Brown gun, this initial velocity appears not only possible, but probable. These tests were made in December, 1893, and again in May, 1896, the first of the trials giving velocities of 3194, 3090 and 3088 feet per second, with average pressures of 65,000, 56,000 and 53,500 pounds per square inch respectively. The difficulty with such velocities seems to lie not so much in the strength of the wire-wound gun as in the erosive action of all powders, though particularly the smokeless variety, on the rifling of the gun when high pressures are unavoidably employed. Lieutenant G. N. Whistler, of the 5th United States Artillery, the engineering expert employed by the trustees of the Brown segmental gun, reports that in the unlined condition of an experimental cylinder, a "slight scoring, following the line of

juncture of the segments, was noticed after a pressure of 43,133 pounds to the square inch. Since the cylinder has been lined, not the slightest scoring of any kind has been observed." As the erosion is most serious, in every description of gun, toward the breech, being caused by the gas of the explosive forcing its way past the gas check of the projectile before the latter has expanded sufficiently to fill the rifled grooves, the Brown segmental guns will have a lining tube inserted part of the way down from the breech, the rifling in the forward end being cut in the bare segments.

Quite recently the United States government is said to have ordered twenty-five 5-inch and twenty-five 6-inch quick-firing guns of the Brown pattern for naval service. These guns will also be forty-five calibres in length, and must stand tests at 2600 feet per second initial velocity. The weight of the 5-inch gun is placed at 7600 pounds; and the weight of the 6-inch at 17,000 pounds. These guns certainly do not show any gain in lightness over British wire-wound guns, which are the only ones now in existence with which to compare them. For example, the standard British Q. F. wire-wound 6-inch gun of forty-five calibres weighs 16,576 pounds, as against the 17,000 pounds of the corresponding Brown gun. Of course, the Brown gun by employing higher velocities may obtain greater muzzle energy, but this may not be practicable for the reason previously given.—*United Service Gazette*, Oct. 8, 1898.

LESSONS FROM THE WAR TO WARSHIP MACHINERY.

The war which has just ended is the first in which modern steam vessels have had a thorough trial, and it seems pertinent, says the report of the Bureau of Steam Engineering, to note the more important lessons which have been taught by our experience. With respect to the machinery they are as follows:

1. The vital necessity of giving the machinery of vessels in reserve frequent tests under working conditions, so that any defects may be discovered and remedied before war makes the vessels' services absolutely necessary. In several cases defects were found after the ships had begun cruising, and the repairs laid them up in the midst of the war.

2. The great importance of having all our naval stations in positions of strategic value properly fitted out for repairs and with adequate supplies of non-perishable stores. It had been evident for a long time that Key West was such a station, but money to put in a proper repair plant was refused year after year and only granted after the war had begun. The movement of large bodies of troops and their equipment almost blocked the railroads, so that after the beginning of the war it was almost impossible to secure the forwarding of tools and supplies.

3. That fresh water for the boilers is almost as important as coal, and that a distilling ship is an important adjunct of a fleet operating away from a base where fresh water can be readily obtained.

4. That every fleet needs a repair ship to enable the efficiency to be maintained without leaving the station, and consequently that several ships should be equipped so as to be ready to proceed with the fleet.

5. The great tactical advantage of water-tube boilers.

6. That if more than two main engines are to be fitted, there should be three engines driving three screws, and not two main engines on each shaft. The New York and Brooklyn had their forward engines disconnected at the time of the Santiago fight and could not stop to couple them. An accident to any part of either of the two engines on a shaft disables half the power; in the three-screw ship this fraction would be only a third.

7. That there should be frequent trials under forced draft to keep the blowers in good condition and to make the men thoroughly familiar with working under maximum conditions. It appears that some of the ships had never been under forced draft since their contract trials until the day of the fight at Santiago.

8. That the location of the forced-draft blowers is a matter of serious importance. In some of our ships, owing to the demand for all other space for other purposes, the blowers had to be located in corners or pockets in the fire-rooms, where it was impossible for human beings to give them proper attention, owing to the intense heat due to lack of ventilation. In the Cincinnati temperatures as high as 205 degrees F. were noted, and the commanding officer, when investigating the case personally, had his face scorched. The blowers must be placed where they can be properly cared for or else they are useless and might as well be left on shore.

9. That the *personnel* of the service should be adequate to the material. It has been notorious for some time that this is not the case, and we are providing for a decided increase in the number of vessels with no increase whatever in the *personnel*. By sending nearly every officer on the active list to sea we were able to give the regular ships a fair complement of trained ones, but had the war been of long duration we should have been greatly embarrassed to supply the places of those disabled or invalided. Volunteers, however well trained in other ways, cannot entirely replace the regular officers.

10. That we must make provision for training the enlisted men of the engineer department. Many of the colliers and auxiliary vessels had to start out with absolutely green crews, many of whom, so far from having the "sea habit," had never been on a vessel of any kind. This must be remedied if our enlarged fleet is to be efficient.

11. That our fighting ships must have the highest practicable speed. There is an almost general agreement on this point among naval men, but if any had thought that this did not apply to battle-ships the fight at Santiago must have shown that the highest practicable speed is just as important in these vessels. It is very gratifying, therefore, that our three new battle-ships are to have speed of at least 18 knots, which is now recognized as the standard.—*The Iron Age*.

THE LARGEST FLOATING DOCK IN THE WORLD.

The great floating dock recently constructed for the Vulcan Company, Stettin, Germany, by Messrs. Swan & Hunter, of Wallsend, Newcastle-on-Tyne, surpasses in capacity the floating dock built by the same firm for the Spanish government and now in operation at Havana. We illustrated the Havana dock in our issue of October 6, 1897, and the remarkable

achievement of towing it successfully across the Atlantic Ocean is fresh in the public mind.

The present dock, like its predecessor, was built from the designs of Messrs. Clark & Stanfield, of Westminster, the well-known dock engineers. It has been constructed with special reference to the lengthening and re-engining of two of the Atlantic liners of the North German Lloyd Company.

The principal dimensions are: Length over all, 510 feet; extreme breadth, 100 feet 9 inches; height from bottom of pontoon to top of walls, 43 feet 7 inches. The internal width is sufficient to allow vessels up to 82 feet beam to be docked, and the depth over the keel blocks is 24 feet. The maximum lifting power is about 12,000 tons.

The dock is what is known as the self-docking type, that is to say, access to all the external surfaces is possible for painting or repairs. Longitudinally it consists of two side walls, between which are connected three pontoons, the centre one being 240 feet long, and the two end pontoons 135 feet. The pumping and controlling machinery consists of eight horizontal centrifugal circulating pumps, placed four in each wall of the dock. These pumps have large vertical shafts, geared by means of bevel wheels and horizontal shafts to two sets of compound engines of 125 horse-power each, which are placed on a deck near the top of the walls. There are four engines in all, and each of them drives two 15-inch centrifugal pumps, the whole machinery being capable of lifting a ship of about 11,000 tons displacement clear of the water in about two and a half hours. The dock is divided into 38 water-tight compartments, each emptied or filled by separate valves. Each engine is supplied by a large, horizontal multitubular marine boiler which is placed in the walls in close proximity to it.

The main line of suction pipes is laid at the bottom of the pontoon walls and runs the entire length of the same. Branches are carried through the walls into the pontoon itself, connection being made by means of flexible joints. The valves for regulating the emptying and filling of the dock, of which there is of course a great number, due to the subdivision of the pontoon, are all manipulated by means of rods and levers from central houses placed one on each wall. From this position also the engines for driving the pumps can be started or stopped at the will of the engineer in charge. The whole of the controlling gear is so arranged that two men, one on each wall, can control the pumping gear of the entire structure.

We have referred to the Stettin dock as being a self-docking structure. It is so named because of the facility with which all parts of the structure can be got at, if desired, for painting, etc. Each pontoon can in turn be detached, lifted, and hung up on the side walls, and while it is in this position any part of it may be examined and repairs, etc., carried out. The underneath portion of the walls, moreover, may be exposed by careening the structure; in fact, any work may be done upon the dock that in any other floating structure would necessitate a visit to a drydock.

In docking a ship, the dock is sunk until the upper floor of the pontoons is well below the level of the ship's bottom. The ship is then floated in between the walls and secured in the desired position. The pumps are then started, and as the buoyancy of the pontoons increases they lift the vessel steadily out of the water.

The advantages of this form of dock are that its first cost is far less than that of a first-class graving dock; it may be moved to any desired

position when the depth of water is sufficient for its operation; it may be built and towed many thousand miles, as in the case of the Havana dock, to its destination, and as compared with the timber docks, it is more reliable and durable.—*Scientific American*.

THE NEW NAVY GUNS.

Designs for a new 6-inch gun, combining the more important features of the Vickers type, the patents for which have recently been secured, are under preparation by the Navy Department, and all new ordnance of this calibre for the naval service will be of this type. The new gun will be almost equal in power to the 8-inch now on ships of the service, and in velocity obtained will far exceed the old ordnance. The important features of the new gun are increased length of tube from forty, the present length, to fifty calibres, which is about that of the 6-inch rifles on the New Orleans, and larger powder chamber. The introduction of smokeless powder has made the increase of velocity possible, and the new gun will have a velocity of not less than 3000 feet per second, exceeding that of the old by from six to eight hundred feet. This will give it an additional penetration of at least two inches more of steel. The weight and cost are increased but little. The Vickers patents enable the Ordnance Bureau to make some important changes in breech mechanism. Sets of forgings for this gun will be purchased shortly, bids having recently been opened from a number of concerns. When delivered these forgings are to be assembled at the gun factory at Washington. At present the gun factory is employed in converting a number of the old 6-inch slow-fire into quick-firing guns, in accordance with the Department's purpose to have all rifles on ship board up to six-inch of the latest type of quick-fire. The new breech mechanism increases the rapidity of fire, besides giving other advantages which make this gun superior in all respects to the old type which is now carried on the Philadelphia and some of the earlier-built ships in the Navy.

Improvements to be made in the larger guns to be manufactured will increase their velocity also. The new 12-inch will have a larger powder chamber and a velocity approximating 3000 feet per second, as compared to 2300 feet, the highest rate now secured. Twelve-inch guns are to take the place of thirteen in all probability on future battle-ships for the Navy, the increased velocities obtainable by the use of smokeless powder rendering this piece more formidable as a weapon than the present 13-inch gun. The lessons of the present war have been few, but important. The importance of length for the smaller type and the superiority of smokeless powder are not exactly novelties, but we have been slow in applying them.—*Army and Navy Journal*, Oct. 15, 1898.

COLT'S NEW MACHINE GUN.

The Colt's Fire-arms Company has, we learn from our American correspondent, brought out a new automatic machine gun, which can be

mounted on a fixed stand or a field carriage, or carried in a long holster by cavalry, or mounted on a police patrol wagon. The gun weighs 40 lbs., the tripod stand 54 lbs. For naval service the weight of a gun mounted on a wheeled carriage with ammunition, etc., is 230 lbs., this design being intended for the use of landing parties. The gun consists of a heavy barrel attached to a casing which contains all the operating mechanism. Towards the muzzle end is a small vent, opening into the barrel, through which the confined gas from the explosion of the powder attempts to escape after the projectile has received its maximum velocity. In so doing the pressure acts upon a small piston which throws an operating lever, causing in turn suitable mechanism to eject the empty shell and place a new cartridge. Springs return the gas lever, which forces the cartridge into the barrel, closes and locks the breech block and cocks the hammer ready to be fired again. If the gun is empty, as in starting, the gas lever is first thrown by hand. When once started, however, the action is entirely automatic, and the gun may be fired singly by pulling the trigger once or continuously by holding the trigger. In the latter case, between 400 and 500 shots can be fired per minute. The handle and trigger are similar to those of a revolver, but there is no guard below the trigger. The cartridges are mounted upon a canvas belt which is coiled up in a box hanging at the side of the gun, so that any movement of the barrel in aiming will not affect the feeding mechanism. The boxes are made in three sizes, containing 100, 250 and 500 cartridges respectively. The gun can be constructed for any kind of rifle ammunition, the standard calibre for the United States navy being 6 mm. or 0.236 inch. Three other standard calibres are also made, 0.7 mm., 0.765 mm. and 0.8 mm. In all cases smokeless powder is required to prevent clogging, and the collection of residue in the barrel is prevented by constructing the hammer to act as a piston for an air pump, which forces a jet of air through the barrel after the empty shell has been ejected. Nickel-jacketed bullets are used, to give the greatest possible penetration, and these give an effective range varying from 1960 feet to 2500 feet, and a penetration of 48 inches to 60 inches of pine, according to the calibre. To avoid accident when a loaded cartridge is left in the barrel, a safety lock is provided, which prevents the hammer from striking the firing pin. The working parts are few, simple and strong, and are so designed that the main spring, firing pin and other parts where there is any possibility of derangement can all be easily and rapidly removed from the rear of the gun without loosening a single screw. The barrel is made unusually heavy, to give weight, prevent injury and obviate the necessity of using the usual water jacket.—*The Engineer*, July 1, 1898.

DAMAGE TO ITALIAN SHIPPING BY GALVANIC ACTION.

An unusual and interesting case has been recently before the Italian courts. The captain of the port of Leghorn, Cavaliere Alcesti Torrini, was the plaintiff in an action against the owners of certain wooden yachts with coppered bottoms lying in the Darsena part of the harbor of Leghorn, to enforce a notice on the owners for the removal of such vessels from that part of the harbor. This notice was made on the grounds that

the new warships and other iron and steel vessels lying in that part of the harbor were damaged by galvanic currents set up from the copper bottoms of the wooden yachts, the contact with the steel vessels being due to ropes which were made fast to different buoys in the harbor or basin. The fact of the damage to steel and iron ships having arisen and of its being due to this cause was clearly established before the court, and the captain's order for the removal of the wooden yachts with coppered bottoms from the Darsena harbor of Leghorn was consequently confirmed by the court.

Prof. Vivian B. Lewes, in a paper read before the Institute of Naval Architects some years ago, stated that damage to shipping was liable to arise from such a cause, and he also put forward the same theory in his book, "Service Chemistry." The fact of the existence of such a danger must be known to very few ship-owners, but it is quite possible that the not infrequent phenomenon of an abnormally rusty bottom of some steel ship might be traced to her having been in galvanic contact with some copper-sheathed wooden vessel.

In commenting upon this case the *Engineer* says that in Italy there is another cause for damage at work, which is not unlikely to manifest itself before long, in so far as several anti-fouling compositions manufactured in Italy rely for their anti-fouling effect solely upon the presence of a very large percentage—30 to 40 per cent.—of metallic copper. Such compositions are applied to the bottoms of a large number of Italian ships, in conjunction with a coat of priming, which is supposed to serve as an insulating medium. However effective powdered copper may be as an anti-fouling medium, our contemporary believes that it cannot be applied with impunity to iron and steel ships. In England anti-fouling paints containing metallic copper are also made, but in no case are they applied to iron or steel ships; they are only used for wooden ships, such as fishing vessels and wooden trawlers, on which they give good results, but manufacturers of composition in this country who supply iron and steel ships have long realized that paints containing metallic copper are absolutely unsuitable for application on steel vessels, a fact on which Prof. Vivian B. Lewes expatiated in his book referred to.

Even if insulated to some extent by a coat of priming paint from the outer surface of the vessel's plates, the presence of 30 to 40 per cent. metallic copper in a paint exposed to the action of salt water must set up a strong galvanic action in the whole structure of the ship, and this cannot fail to exhaust itself on those parts of her structure which are most exposed to corrosion or least protected against it; for instance, the floor plates, tank bearers, tank tops, bunkers, etc., for the galvanic current produced on the outside surface fills the whole metal structure of the ship, and whichever plates are most susceptible to corrosion through exposure or otherwise will be most attacked by it. For reasons of cheapness paints so manufactured have, during the last year or two, been largely used by Italian ship-owners, and have even been applied to several mail and passenger steamers, on which they are undoubtedly a source of great danger to life and property. No doubt Italian ship-owners who have indulged in such false economy will, when passing their vessels through their periodical surveys, pay a bitter penalty for their ignorance and parsimonious practices. In the meantime British ship-owners should be warned against accepting any anti-fouling paints in Italian ports without a guarantee that they are free from metallic copper.—*Iron Age*.

PROPOSALS FOR A FLOATING DRYDOCK.

The Bureau of Yards and Docks, Navy Department, will receive proposals up to October 31 for a floating drydock, the cost not to exceed \$200,000, to be located at Algiers, La. The length over all is 525 feet, draft of water over keel blocks 28 feet, width in clear not less than 100 feet. The bidders are to make their own designs. The dock must be capable of lifting a ship of 15,000 tons displacement above the level of the river, and must be proportioned for a battle-ship weighing that much and 450 feet length, and having two-thirds of her weight centered in the middle half of her length. The entire structure must be of steel except the keel blocks, bilge blocks and shores. The power for the operation of the dock may be steam, electric, hydraulic or pneumatic, and may be generated upon shore or upon some permanent structure on the border of the waterfront. Docks designed as single structures must be strong and stiff enough longitudinally to safely distribute the load over the entire length of the dock if the vessel be docked in one end thereof. Designs for sectional docks must make adequate provision for connecting the sections so that the dock may act as a unit and the sections be kept level and in line without straining the ship, so that in case one of the sections should lose all its buoyancy the connections of the sections shall be capable of distributing over the remaining sections the weight of the injured section and all the parts of the ship over the whole.—*Iron Age*.

A NEW METHOD OF MAKING HARD-FACED ARMOR.

Taking advantage of the fact that by suitably controlling the process of cooling it is possible to obtain some of the newer alloys of iron with nickel, cobalt and manganese in either a hard or a malleable condition, M. Jean Werth, manager of the Société Anonyme des Hauts Fourneaux et Acieries de Denain et Anzin, has devised a new process of making armor plate. M. Werth's contention is that the plate should have the same chemical composition throughout, and that the hard face should be obtained entirely by a process of tempering. Ordinary carbon steel in large masses cannot be tempered satisfactorily, but when alloyed with suitable proportions of nickel, cobalt or manganese it is possible to obtain the metal in a hard state by heating it up to a bright red and allowing it to cool in the air; whereas, if heated only to a dull red and cooled, the metal will be malleable and comparatively soft. The steel used by M. Werth is open-hearth metal, free from sulphur and phosphorus. It contains from 5 to 15 per cent. of nickel or cobalt, and from 2 to 12 per cent. of manganese; while within certain limits silicon, chromium or tungsten may be present without interfering with the process of tempering. In its soft state such a steel has a tensile strength of 110,000 to 140,000 pounds per square inch, and a strip $1\frac{1}{4}$ inches thick can be bent without cracking round a radius equal to its thickness. After the plate is completed it is tempered by making it part of the side or bottom of a furnace. The face next the fire thus becomes heated to a bright red, while by means of water or air the temperature of the back face is kept down to 800 or 900 degrees F. To insure good results the heating is effected very gradually, the plate being put into a cold furnace;

and by preference gas fuel is employed in the latter. Another method of effecting the heating, which is, however, only applicable to flat plates, is to immerse their front faces in a bath of red-hot lead, the temperature of which is maintained very uniform. When ready the plate is removed from the furnace and cooled at the back, until the front face has sunk down to a temperature of 800 to 900 degrees F., when no further attention is required, though if warped it can now be straightened before the cooling is finished.—*Iron Age*.

CONTRABAND OF WAR.

WASHINGTON, D. C., June 28, 1898.—The Navy Department, in conjunction with the State Department, has issued a long expected order defining contraband of war, which is embraced in a series of "Instructions to blockading vessels and cruisers." These instructions embrace many matters of only special interest to the commanders of vessels blockading Spanish ports, but the provisions relating to contraband of war are contained in the following sections:

"The term contraband of war comprehends only articles having a belligerent destination, as to an enemy's port or fleet. With this explanation the following articles are, for the present, to be treated as contraband:

"Absolutely Contraband.—Ordnance, machine guns, and their appliances, and the parts thereof; armor plate, and whatever pertains to the offensive and defensive armament of naval vessels; arms and instruments of arms, steel, brass or copper, or of any other material, such arms and instruments being specially adapted for use in war by land or sea; torpedoes and their appurtenances; cases of mines, of whatever material; engineering and transport materials, such as gun carriages, caissons, cartridge boxes, campaigning forges, canteens, pontoons; ordnance stores, portable range-finders, signal flags destined for naval use, ammunition and explosives of all kinds; machinery for the manufacture of arms and munitions of war; saltpeter; military accoutrements and equipments of all sorts; horses.

"Conditionally Contraband.—Coal, when destined for a naval station, a port of call, or a ship or ships of the enemy; materials for the construction of railways or telegraphs, and money, when such materials or money are destined for the enemy's forces; provisions, when destined for an enemy's ship or ships, or for a place that is besieged."

It will be seen that the list of contraband articles is restricted to those plainly intended for use in war, and does not embrace raw material unless its ultimate use for the purpose of carrying on war is clearly evident. Thus, there is no embargo upon ores, metals, tools, machinery, etc., except as clearly defined in the section quoted when intended for the manufacture of appliances or munitions of war.—W. L. C.

THE RADDATZ SUBMARINE BOAT.

A Milwaukee press dispatch states that on the 21st inst. a public test of the Raddatz submarine boat was made in the presence of a large

party, which included a number of engineering experts, among whom were Superintendent Reynolds of the E. P. Allis Works and City Engineer Benzenberg. The test was continued for several hours. Mr. Raddatz and his engineer went down in the boat, and after a short delay caused by a foul anchor the boat dropped out of sight and remained under water cruising around for half an hour, its presence under the water being indicated by a float of wood, which was made fast to the turret. Mr. Raddatz then brought the boat to the surface with the body just under the water and took short runs around the bay.

Once more he disappeared and remained down this time for 20 minutes and again came to the surface, and threw off the top of the turret.

The boat drops gradually and on a level keel and comes up the same way. The disappearance under water and the reappearance on the surface are apparently regulated by the water ballast, as the boat is so sensitive that any extra weight inside renders it necessary for the inventor to readjust his apparatus. The air is supplied by chemicals, which are contained in a box that is securely locked. These chemicals furnish air enough, the inventor says, to supply one man under the water for 24 hours.

The boat is operated under some difficulties, as she is not large enough to install the power that is necessary. It is probable that a new boat will be built having a diameter of 7 feet instead of 4, which is the diameter of the present boat.—*Iron Age*.

A NEW QUICK-FIRE NAVAL GUN.

British naval ordnance experts have developed a gun which for rapidity of fire is said to excel any of its type and class so far known. The rifle is of 6-inch calibre, wire wound and capable of tremendous penetration, velocity and quickness of fire. Reports of experiments recently conducted with it at Portsmouth, England, received by the Naval Intelligence Office at Washington, show that the piece weighs only a little more than 7 tons and is far lighter and stronger than the old type. Compared with the old pattern 6-inch rifles such as are now mounted on the Philadelphia and some of the first ships of the navy, one of the new guns is equal in effectiveness to two of them on account of the improved breech mechanism, which admits of remarkable rapidity of firing. A single motion opens and closes the breech. An automatic attachment is fitted for working the primer so that when the breech is closed a slide automatically covers the tube until the plug is locked, and when the plug is opened the empty primer is automatically ejected.

In the recent trials a velocity was obtained of 2780 feet a second, the pressure being 15.9 tons. The striking energy was 5374 foot-tons, as compared with the 3356 foot-tons for the ordinary gun. Aiming at a target 3000 yards away, the gun was fired at a rate of one round in ten seconds. In all 110 rounds were fired, the breech mechanism working quickly and easily in every case. The large and heavy metallic cartridge cases have been done away with, effecting a saving in weight and space in the magazines, simplifying the operations of loading and rendering unnecessary a cartridge case ejector in the breech mechanism.

Another trial of the gun and mount took place later for the purpose

of testing the accuracy of the gun after 200 rounds had been fired from it, and to submit it to a test for rapidity of fire under service conditions. In the accuracy test ten shots were fired and the gun showed no deterioration in that respect, in spite of the large number of rounds previously fired. The test for rapidity was made with a crew of trained seamen in charge of an officer from the gunnery ship *Excellent*. Thirty-six rounds were fired in 4 minutes and 47 seconds, including the time lost in taking temperatures of the breech-plug head, making the rate of fire one shot in 8 seconds approximately.—*Iron Age*.

A Parliamentary paper was issued in July containing a return showing the fleets of Great Britain, France, Russia, Germany, Italy, the United States of America and Japan, distinguishing the various types of vessels built and building. The return shows the date of launch, displacement and armaments reduced to one common scale. It will be observed that this year the return includes for the first time the fleet of Japan. The last time the return was issued was in November, 1896. Vessels which appeared on March 31st, 1898, in the official list of each navy as built or building are enumerated, including under the latter head those for which on that date money had been appropriated and which were shortly to be laid down. The following tables exhibit the total number of vessels in each class belonging to each nation:

VESSELS BUILT.

	Great Britain.	France.	Russia.	Germany.	Italy.	United States.	Japan.
Battle-ships	52	27	12	17	15	5	3
Cruisers, armored	18	9	10	3	3	2	1
" protected	95	30	3	7	15	14	10
" unprotected	16	16	3	21	1	10	8
Coast-defense vessels, armored.	15	14	15	11	..	20	3
Special vessels	3	1	5	1	2	1	..
Torpedo vessels	35	13	17	2	15	..	1
Torpedo-boat destroyers	50	..	1	..	..	..	..
Torpedo-boats	98	211	174	113	142	8	44

VESSELS BUILDING.

Battle-ships	12	8	6	5	2	8	3
Cruisers, armored	8	10	1	2	2	..	6
" protected	24	10	3	8	3	1	6
" unprotected .....	..	..	..	..	..	..	1
Coast-defense vessels, armored.	..	..	1	..	..	..	..
Special vessels .....	..	..	..	..	..	..	..
Torpedo vessels .....	..	2	..	..	..	..	..
Torpedo-boat destroyers	46	8	28	1	1	20	8
Torpedo-boats .....	..	38	..	9	2	22	12

The return is, to a certain extent, misleading, as there is no attempt at classification, a third-class battle-ship like the *Neptune*, for instance, being placed in the same list with the *Majestic*; while the supplemental pro-

gramme proposed by Mr. Goschen in July, and approved by the House of Commons, adding 4 battle-ships, 4 cruisers and 12 torpedo-boat destroyers to the building programme, is of course not included.

In the subjoined table we give the number of ships of the principal classes built, building and proposed to be laid down during the present financial year (our own supplemental programme being included) compared with those of France and Russia:

First-class battle-ships—	Built.	Building and to be laid down.	Total.
Great Britain	29	16	45
France	15	5	20
Russia	7	11	18

Great Britain has therefore 45 first-class battle-ships built, building and to be laid down, as against 38 for France and Russia.

Second-class battle-ships—	Built.	Building and to be laid down.	Total.
Great Britain	10	0	10
France	10	1	11
Russia	6	0	6

Great Britain has therefore 10 second-class battle-ships as against 17 of France and Russia.

First-class armored cruisers (effective)—	Built.	Building and to be laid down.	Total.
Great Britain	9	12	21
France	6	10	16
Russia	6	4	10

Giving Great Britain 21 to 26 of France and Russia of this class.

First-class protected cruisers—	Built.	Building.	Total.
Great Britain	13	8	21
France	4	4	8
Russia	0	0	0

Giving Great Britain 21 to 8 of France and Russia of this class.

Second-class cruisers—	Built.	Building.	Total.
Great Britain	49	5	54
France	16	2	18
Russia	3	6	9

Giving Great Britain 54 to 27 of France and Russia of this class.

Third-class cruisers—	Built.	Building.	Total.
Great Britain	36	10	46
France	10	3	13
Russia	13	0	13

Giving Great Britain 46 to 26 of France and Russia, and a grand total of cruisers of all classes of 142 to 87 of France and Russia.

Torpedo-boat destroyers—	Built.	Building.	Total.
Great Britain	81	27	109
France	0	8	8
Russia	1	28	29

Giving Great Britain 109 torpedo-boat destroyers as against 37 of France and Russia.—*Journal of the Royal United Service Institution.*

THE INCREASE IN THE WORLD'S PRINCIPAL NAVIES.

Among the late reports of the Office of Naval Intelligence, in the U. S. Navy Department, is one by Lieut.-Commander W. H. Driggs, U. S. N., on "The Increase in Naval Strength" of England, France, Germany, Russia and Japan. At a time when additions to our own Navy are being looked upon with especial favor it is interesting to note what other nations are doing in this direction, and for this reason we make a brief abstract of the paper of Lieut.-Commander Driggs.

England, as always in naval matters, is far in the lead. The budget voted for 1897-98 amounts to about \$107,000,000, providing for an expansion in all branches of the navy. The number of officers and men has been increased from 88,850 in 1895 to 100,050 in 1897, including in these figures the coast guard. The total of ships under construction and to be built during the fiscal year of 1897-98 is 108, including 14 battle-ships, 8 first-class cruisers, 9 second-class cruisers, 10 third-class cruisers and 52 torpedo-boat destroyers.

Russia is not only adding to her naval strength, but is also actively engaged in opening up harbors and channels for strategical purposes and establishing naval bases in foreign countries. The naval programme that was mapped out in 1896 involves an expenditure of \$318,000,000, though the exact number of ships contemplated is not specified by Lieut.-Commander Driggs.

France in her budget for 1898 asks for \$55,108,000 for naval purposes, allotting nearly \$20,000,000 of this for new ships. Her present building programme extends over a period of eight years, and involves an expenditure of about \$144,300,000. Like Russia, she is providing for better harbors and channels at home, and is creating bases for supply and repair in foreign waters. Admiral Besnard, the French Minister of Marine, calls especial attention to the need of fast cruisers in modern naval warfare, and to emphasize his demand for additional ships of that class in the French navy he presents two tables showing certain naval conditions in May, 1897, as follows:

AVAILABLE.	England, Triple Alliance, Russia, France.			
	England.	Triple Alliance.	Russia.	France.
First-class cruisers	24	3	5	8
Second-class cruisers	61	26	7	12
Dispatch boats	50	19	20	13
Torpedo-boats and torpedo-boat destroyers..	51	38	9	13
Total.....	195	86	41	46
UNDER CONSTRUCTION.	England, Triple Alliance, Russia, France.			
	England.	Triple Alliance.	Russia.	France.
First-class cruisers	12	10	6	5
Second-class cruisers	6	3	1	7
Dispatch boats	10	5	0	1
Torpedo-boats and torpedo-boat destroyers..	14	1	1	3
Total.....	42	19	8	16

In addition to the above France had in 1897 10 battle-ships and 7 armored cruisers under construction, and, counting all classes, she had 63 warships under construction in that year.

Germany in now putting into execution a naval programme laid down in 1873 and deferred until the present time for lack of funds. This programme calls for an active fleet of 17 battle-ships, 8 armored coast-defense ships, 9 large cruisers and 26 small cruisers. In addition, she proposes a reserve fleet of 2 battle-ships, 3 large cruisers and 4 small cruisers. The total proposed and those classed as available by the German government are shown in the following table:

	Total authorized.	Available.
Battle-ships	19	12
Armored coast-defense	8	8
Large cruisers	12	10
Small cruisers	30	23

Germany recognizes the fact that to maintain a modern fleet she must provide for the replacement of old-type ships. To this end she fixes the period of efficiency of battle-ships and armored coast-defense ships at 25 years, of large cruisers at 20 years and of small cruisers at 15 years; after these periods of service they would have to be replaced by others of the newest type. The *personnel* of the German navy is to be raised from 18,138, its present strength, to 26,637 in 1904.

Japan has a naval programme to be completed in 1906, and during this period she proposes to spend \$192,396,546. This programme calls for the addition to her navy of the following vessels: 4 battle-ships of 15,000 tons, 4 armored cruisers of 9500 tons, 3 second-class protected cruisers of 4800 tons, 2 third-class protected cruisers of 3200 tons, 3 torpedo gunboats of 1200 tons, 11 torpedo-boat destroyers and 89 torpedo-boats. Prior to her war with China, Japan only had 18 cruisers ranging from 1500 to 4000 tons. When those authorized are completed she will have a navy of 65 ships of war, 11 torpedo-boat destroyers and 115 torpedo-boats. Japan now has 1725 officers in her navy exclusive of midshipmen and sub-lieutenants.

In the above lists the total proposed expenditure for naval purposes, according to adopted programmes, amounts to \$1,001,690,000, all to be expended before 1906 by five nations only.—*Engineering News and American Railway Journal*.

According to a report issued by the Ministry of Marine, the officers' list of the Imperial German navy is constituted as follows: The Secretary of State for the Navy, 2 admirals, 3 vice-admirals, 9 rear-admirals, 47 captains, 82 commanders, 220 lieutenant-commanders, 254 lieutenants, 173 sub-lieutenants, 1 colonel and 39 officers of marine infantry, 115 engineers, 132 surgeons, 39 torpedo officers and engineers, 55 ordnance officers, 96 paymasters, and 25 pensioned officers, making a total of 1299 officers of all ranks, in addition to whom there are 267 midshipmen and naval cadets. The *personnel* of the men consists of 979 warrant officers, 4382 petty officers, 16,679 seamen, 659 bandsmen and artificers, etc., and 750 boys including their instructors, making a grand total of 23,449 men. The men are divided as follows: Two seamen's divisions, each with two subdivisions and one subdivision of boys, 10,722 men; two dockyard divisions

of five companies each, 6305 men; two torpedo subdivisions, 2563 men; four seamen-gunner subdivisions, 2202 men; two marine battalions of four companies each, 1201 men; the gunnery staff, 110 men; torpedo and submarine mining staff, 165 men; surveying staff, 14 men; and clothing department, 167 men; making a total as given above of 23,449 men.—*Royal United Service.*

THE NEW BATTLE-SHIPS.

WASHINGTON, D. C., September 6, 1898.—The anticipation of the Navy Department experts, who have predicted that the contractors proposing to build the battle-ships Nos. 10, 11 and 12 would be able to guarantee the highest speed yet secured in an American vessel of this class, were realized when the bids for these vessels were opened on the 1st inst. At this writing it seems altogether probable that the Government will award one vessel each to the firm of Wm. Cramp Sons of Philadelphia, the Union Iron Works of San Francisco, and the Newport News Ship Building and Dry Dock Company. This result is especially gratifying in view of the fact that the Department's original plans provided only for the construction of vessels capable of making 16 knots. These plans were opposed with much vigor by Chief Engineer Melville, who insisted that for the amount available vessels of 18 and 19 knots could be constructed having greater radius of action and an adequate coal capacity. Chief Melville's representations were urged upon the Department with so much energy that an informal notice was finally sent to all probable bidders to the effect that, other things being equal, speed would be an important consideration in the awarding of contracts. The builders promptly responded to this suggestion, and it is exceedingly gratifying to the Department to know that all of the vessels to be contracted for will have a speed at least 2 knots higher than the original specifications called for. Following is the official summary of the bids opened:

J. H. Dialogue & Co., of Camden, N. J.—One ship on Department's plans, speed 16 knots, delivered in 33 months, price \$2,840,000.

Newport News Ship Building Company—One ship on Department's plans, speed 16 knots, delivered in 31 months, price \$2,580,000; one ship on contractors' plans, speed 17 knots, delivered in 32 months, price \$2,680,000; one ship of 12,850 tons on Department's plans modified by details of Bureau of Steam Engineering, speed 18 knots, delivered in 32 months, price \$2,880,000.

Wm. Cramp Ship Building Company, Philadelphia—One ship on Department's original plans, speed 16 knots, delivered in 29 months, price \$2,650,000; two ships of the same class for \$2,625,000 each; one ship of 11,500 tons on contractors' plans, speed 17 knots, delivered in 32 months, price \$2,725,000, or two of the same class for \$2,700,000 each; and one ship of 12,150 tons on contractors' plans with modified details of Bureau of Steam Engineering, delivered in 32 months, price \$2,885,000, or two of the same class for \$2,870,000 each.

Union Iron Works of San Francisco—One ship on Department's original plans, speed 16 knots, delivered in 31 months, price \$2,674,000; one ship on contractors' plans, speed 17 knots, delivered in 31 months, price \$2,725,000; one ship of 12,200 tons on contractors' plans with modified

details of Bureau of Steam Engineering, speed 18 knots, delivered in 33 months, price \$2,899,000.

Although three of the contractors offered to build battle-ships of 18 knots speed, all their bids ranged under the maximum price fixed by Congress in the last annual appropriation bill authorizing these vessels, and the Department, therefore, need only consider the proposals for the highest rate of speed. As the Department is always anxious to distribute its contracts as widely as possible among responsible bidders in order to secure the earliest possible delivery, and also to keep the maximum number of shipbuilders in the field for Government work, the officials were much gratified to find that, while the bid of the Union Iron Works was the highest submitted, yet it does not exceed by over 4 per cent. (the limit fixed by law as a concession to Pacific Coast builders) the bid of the Cramps, hence one of the vessels may be awarded to the company who have added so much to their reputation by the wonderful performances of the Oregon in the late war. As the Newport News Ship Building Company only bid on one vessel, leaving the competition for the other two between the Union Iron Works and the Cramp Company, the 4 per cent. provision comes in opportunely to enable the Department to award one vessel to each firm. There is a possible, though not a probable, contingency that the proposition of the Newport News Company may be rejected because of the unwillingness of the Department to adopt the plan submitted, which is original with them, although incorporating certain of the high speed suggestions of the Bureau of Steam Engineering. In case this design is disapproved the Cramp Company will probably be awarded contracts for two vessels.

The new battle-ships will be at least 1000 tons larger than the Illinois class, upon which the original specifications were based. In the original design the general characteristics were stated as follows: Length at normal displacement, 368 feet; molded breadth at water-line, 72 feet; mean draft at normal displacement, 22.5 feet; normal displacement, 11,500 tons; coal capacity, loose stowage, 1200 tons. The Cramp design involves the lengthening of the ships about 15 feet, which gives sufficient room for the introduction of machinery with Niclausse water-tube boilers for a speed of 18 knots. It is also believed that greater coal capacity will be developed, and should it prove practicable to decrease the thickness of the armor plates, as a result of the test of Krupp plates now in progress, a very material increase in steaming radius would be secured.

The Newport News Company also propose to lengthen the Department's designs nearly 20 feet, increasing the displacement to about 12,500 tons. Cylindrical boilers will be used with Powden forced draft.

The Union Iron Works adopted the suggestion of the Bureau of Steam Engineering as to the lengthening of the hull, and will employ Ward water-tube boilers, which they originally placed in the coast-defense vessel Monterey, which was built by this firm at San Francisco in 1890. These boilers have given excellent satisfaction, the reports showing economy of fuel in addition to ability to get up steam in the shortest possible space of time. The experience of Admiral Sampson's fleet in destroying the Spanish squadron off Santiago has demonstrated the importance of being able to make steam rapidly from cold water, and the water-tube boiler, which has been strongly advocated for battle-ships by Chief Engineer Melville for more than a decade, has received a decided impetus.—*Iron Age*.

SHIPS OF WAR.

[ARGENTINE.]

THE ARGENTINE CRUISER GENERAL SAN MARTIN.

This vessel was constructed and completely finished by Messrs. Orlando Brothers in their dockyard at Leghorn. Her principal dimensions are as follow: Length between perpendiculars, 100 metres (328 feet); beam, 18.71 metres (61 feet 10 inches); depth moulded, 12.19 metres (40 feet); mean normal draught, 7.10 metres (23 feet 3½ inches); displacement, 6882 tons. The hull is of Siemens-Martin steel with a double cellular bottom, divided by numerous water-tight compartments and by numerous water-tight transverse bulkheads into fifteen main water-tight compartments.

The protection consists of an armored belt 2.75 metres (9 feet) in depth, of a maximum thickness of 150 millimetres (5.90 inches), extending right fore and aft, and 6 feet below the load water-line. In the central part of the ship this side armor is increased up to the upper deck, forming a redoubt which is closed in at the two ends by armored bulkheads 120 millimetres (4.72 inches) in thickness, and extending from the lower to the upper deck. The turrets of the large guns are within the redoubt thus formed, as well as the broadside quick-firers. An armored deck of turtle-back form, and of the mean thickness of 37 millimetres (1.46 inches), runs from stem to stern. The upper deck, within the redoubt, is also covered with a plate 40 millimetres (1.58 inch) thick, while the lower deck outside the redoubt has one plate 20 millimetres (0.79 inch) thick. For the length of the engine and boiler-rooms the double-bottom construction extends up the side of the ship to the underside of the armored deck, and from this point to the gun deck there is a cofferdam at each side. The nickel-steel plates used for armor were manufactured by the Società degli Alti Forni Fonderie e Acciaierie at Terni, with a special process of cementation similar to Harvey's.

The armament of the General San Martin is as follows: Four guns of 203 millimetres (8 inches) calibre, situated in pairs on two revolving armored turrets, 102 millimetres (4 inches) thick, at the end of the redoubt, with the very wide angle of training of 274 degrees; ten guns of 152 millimetres (6 inches) arranged in battery on the redoubt, with an arc of 110 degrees, the fore and aft guns being able to fire in the line of keel; six guns 120 millimetres (4 feet 7 inches) on the upper deck, the central weapons having an arc of 130 degrees, the bow and stern guns 155 degrees, and firing in the line of keel. Twelve guns of 57 millimetres, ten Maxim machine guns of 37 millimetres, two landing guns 75 millimetres, two landing mitralleuses of rifle calibre, and four torpedo tubes on the broadside on the lower deck for discharging 18-inch torpedoes. Most of the artillery was furnished by Messrs. Armstrong, of Pozzuoli, and is all according to the latest models, wire construction, single movement pedestal mounting with quick double electric or percussion firing. Whitehead, of Fiume, furnished the torpedo-launching tubes for firing with cordite.

The magazines are very large, the various kinds of projectiles and charges and cartridges being arranged in separate rooms. The ammunition service, studied by Messrs. Orlando with the greatest care, together

with the arrangement and distribution of the projectiles, is performed by 16 vertical and inclined elevators of a special type, constructed according to the designs of Messrs. Orlando, and furnished, along with their hand and electric motors, by the Società Nazionale delle Officine di Savigliano, of Turin.

Electric motors for the service of the turrets, combined with hand and speed-regulating gears, insures rapidity in working and instant stopping.

The crew consists of 500 men and 40 officers. The admiral's apartment includes a stateroom and a dining-room. The officers' messroom is in carved wood and inlaid in the Italian style. The ventilation of all the rooms is by a distribution of ventilating tubes and other mechanical apparatus.

The electric plant for illumination and transmission of energy for the service of the artillery and projectors consists of five compound-wound dynamos of 300 amperes and 80 volts, coupled to vertical compound tandem engines furnished by Franco Tosi, of Legnano. Two are arranged over and two under the armored deck. The dynamos are interchangeable. There are 700 lamps and four reflectors of 16 lamps for overboard illumination during coaling; five projectors of Schuckert's type with parabolic mirrors arranged as follows: One on the mast of 750 millimetres (29.5 inches) with 360 degrees range of view; four of 600 millimetres (23.62 inches) in the battery with 180 degrees range. The foretop searchlight is to be operated from a distance by electric motors.

The propelling machinery, furnished by the Società Industriale Napoletana Hawthorn Guppy, of Naples, consists of two sets of triple-expansion vertical engines with three inverted cylinders of 1.04 metres (42 inches), 1.610 metres (63.38 inches), and 2.360 metres (82.91 inches) diameter and 1.17 metres (46 inches) stroke. The high-pressure cylinder has a piston valve, the others ordinary slide valves, and Joy's assistant cylinders. The cylinders are all steam-jacketed. The slide motion is with double bar links on the Stephenson system, and the starting motion includes steam and hand independent apparatus. The two main condensers, of gun metal, have a cooling surface of 16,000 square feet. The circulation water is provided by two centrifugal pumps of 1.22 metres (48 inches) diameter, driven by independent compound engines. They have each of them an auxiliary air pump. The two single-acting main air pumps, with cylinders 686 millimetres (27 inches) in diameter by 533 millimetres (21.78 inches) stroke, are driven by side levers from the intermediate cylinder crosshead. Two main Worthington feed pumps draw from hot wells or from the compartments of the double bottom fitted as fresh water tanks. Two centrifugal ventilators of 1.22 metres (48 inches) diameter are fitted for ventilating the engine-rooms.

The two propellers are of gun-metal, each with four blades, and have a diameter of 4.876 metres (16 feet) and a pitch of 7.190 metres (23 feet 7 inches).

Steam is provided by two groups of four boilers situated abaft and forward of the engines. The communication is through a tunnel fitted with water-tight doors. As in the engine compartment, there is a centre line longitudinal water-tight bulkhead, so that each pair of boilers are in a separate compartment. All the boilers are single-ended, the four forward boilers and the first two abaft the engines having a diameter of 4.74 metres (15 feet 6½ inches) with four Fox's furnaces 1.019 metres (39 inches) diameter. The total grate surface is 72 square metres (775

square feet), and the heating surface 1997 square metres (21,427 square feet). The steam pressure is 155 lbs. to the square inch. For the forced draught every boiler is provided with an under-grate blowing centrifugal ventilator, while steam elevators and hydraulic ejectors perform the ash service. The two funnels have a diameter of 2.438 metres (8 feet), with a height of 22.90 metres (75 feet) from the grate level.

Four Worthington auxiliary feed pumps of 127 millimetres (4.99 inches) diameter are placed in the boiler-rooms, and two of similar size for the bilge, and two of 178 millimetres (7 inches) diameter for the fire service.

There is an auxiliary boiler, 2.43 metres (8 feet) in diameter, arranged on the armored deck; it has two furnaces with a grate surface of 25 square feet, while it has a heating surface of 629 square feet, and works at 155 lbs. pressure.

The bunkers are arranged on and beneath the armored deck, and have a respective capacity of 673.2 and 638.4 metres, in all 1311.66 metres (about 46,300 cubic feet).

Amongst the auxiliary machinery on board is a 380-millimetre (15-inch) Worthington steam exhaust pump, two Yaryon distillers, each with a capacity of 30 tons of water per 24 hours; several Dawton service and fire pumps; a vertical double-cylinder engine, 300 millimetres (11.18 inches) in diameter, for the anchor service, acting independently; three large windlass heads and a central capstan; a double independent service of steam-steering engines, arranged under the armored deck in two compartments, a two-cylinder mooring winch with 228-millimetre (9-inch) cylinders, and a large workshop for repairs, the machinery being driven by electric engines. We may also note the landing gear for 152-millimetre guns, those for the torpedo manœuvring, the electric gear for transmission of the orders to the artillery, the electric gear (Molinari's system), showing the engine revolutions, all of them arranged on the conning bridge and in the armored turret.

The General San Martin has 10 boats, of which two are steam cutters and four lifeboats, all to be worked by steam derricks and davits. There is a mooring winch provided with suitable drums for wire cable. All the gear was submitted by Messrs. Orlando to severe tests, under the survey of a commission of Argentine officers presided over by the Commander Sir Manuel José Garcia, and before by the Comodoro Martin Rivadavia, who signed the contract of this ship.

The trials of the artillery took place on February 2, 3, 4 and 5 at Spezia, under the control of the Royal Italian navy, and with the assistance of Argentine officers, and the results proved most satisfactory. Neither the ship nor the inside fittings underwent the slightest damage during the firing of the powerful artillery, and the solidity of the construction, as well as the great military value of the ship, was thereby well tested. Equally satisfactory proved the trials of illumination, of the firing of torpedoes, and the working of the projectors, as well as those of the electric firing of the guns, which executed a simultaneous firing of eight guns, say five guns of 152 millimetres and three guns of 120 millimetres from the same side, without causing the least damage to any part of the ship.

Three speed and engine trials were carried out under the direction of the naval architects and mechanical engineers, Messrs. Giuseppe and Salvatore Orlando, as representatives of their firm, and of Mr. Fowley, representing the firm Hawthorn Guppy. The ship was entrusted to

Commander Cap. Chiodo, under the control of the Argentine Commission, presided over by Commander Manuel José García, who, owing to the excellent results obtained, considered these three preliminary trials as definite and conclusive.

The first six hours' natural-draught trial took place on February 8, on the following course, viz. Scoglio Feraie-Torre Guardiola, 2.20 nautical miles of the beautiful Gulf of Spezia. The medium draught of the ship was 7.155 metres, somewhat in excess of the normal.

The sea was "agitated," there being a strong north wind blowing. The result was as follows, viz.: Mean speed, 18.071 knots; maximum speed, 18.439 knots; mean revolutions, 93.87; maximum revolutions, 95.5; mean indicated horse-power, 8285.8; maximum indicated horse-power, 8832; slip of propeller, 17 per cent.; coal consumption per indicated horse-power, 0.083 kg. (1.77 lbs.); mean pressure in the boilers, 144.2 lbs.; mean pressure at the valve chests, 139.86 lbs.

The second trial at progressive speeds, from 10 to 18 knots, took place on the course Scuola-Tino (1.005 nautical miles), off the Gulf of Spezia, on February 16, and served to trace the real speed curve and to ascertain the slip of the screws. The mean draught of 7.131 metres was also in that instance in excess of the normal one, while a slight west-southwest wind kept the sea rather rough. The depth of water, which is shallow, evidently influenced the speed adversely. The results obtained were from 10.021 knots up to 18.17 knots; 48.3 revolutions up to 92.84 revolutions; 1124.47 I. H. P. up to 8285 indicated horse-power; slip, 10 to 17 per cent.

In the two hours' forced-draught trial of March 22 on the original course of 2.2 miles—with a mean draught of 7.12 metres—the mean speed of 19.68 knots and the maximum speed of 20.06 knots was obtained with 104 revolutions and 12,436.5 indicated horse-power. The air pressure was on the average 25.6 millimetres (1 inch) of water, while the contract permitted 40 millimetres (1.6 inch). Not the slightest damage occurred either to the engines or the boilers, which maintained the almost constant pressure of 148 lbs. It is noteworthy that during the trial the regulating valve maintained the same opening, and that among the steam jackets only the high-pressure one was supplied with steam. There was no serious vibration, and all went on, as in the preceding trials, with the greatest regularity. In consequence of such good results, the Argentine Commission expressed to Messrs. Orlando their highest satisfaction. The designs of the hull are by Mr. Masdea, inspector of the Royal Italian navy. The modifications relating to the armament were studied and executed by Messrs. Orlando, agreeably to the wishes expressed by Comodoro Martin Rivadavia, of the Argentine navy. In the same dockyard at Leghorn is now in an advanced stage of armament another armored cruiser, the General Belgrano, also for the Argentine government.—*Engineering*.

[AUSTRIA.]

THE AUSTRO-HUNGARIAN TORPEDO-BOAT BOA.

The Boa, sister ship to the Viper, and one of four vessels ordered by the Austro-Hungarian government in consequence of the results obtained with the latter, made an unofficial trial, or rather pleasure trip, from Greenwich Pier round the Nore lightship and back on Tuesday last.

The Boa differs but little from the Viper. She is, however, some 5

feet longer and 6 inches wider, being 152 feet 6 inches long, with 15 feet 3 inches in beam. She is propelled by a single screw driven by a three-cylinder triple-expansion engine, with diameters 18 inches, 26 inches and 39½ inches by 18 inches stroke. The engines are nominally of 2000 horse-power, and make at full speed some 340 revolutions per minute. Carrying a load of 44 tons, which brings her down to maximum service draught, she made on her three hours' official trial a speed of 24.265 knots, the steam pressure being 180 lbs. and the air pressure only ¾ inch. This figure is particularly noteworthy; the ease with which the boilers make steam is quite remarkable. When running at some 15 to 16 knots at natural draught on Tuesday we found the firemen lolling and the fire-doors half open. The boilers are placed face to face. A description which we believe is practically correct for the present case will be found in the issue of *The Engineer* above referred to. We note from that that the heating surface is 1868 square feet in each boiler, and the grate area 35 square feet in each. The boilers are, of course, of the Yarrow type, and have two fire-doors and a common grate each. The pressure fan is placed horizontally in the raised "roof" of the stokehold, and is driven by means of a vertical shaft by a small single engine placed on the floor of the hold. The bunkers on each side of the hold carry sufficient coal to give a radius of action of 1500 knots at 10-knots speed. Her armament consists of three 18-inch swivel torpedo tubes—two placed on each side of the bow some distance behind the turtle-back and one at the stern; and two 3-pounder quick-firing guns mounted on pedestals almost touching the conning tower on either side, and consequently just behind the turtle-back. Rails for the transport of the torpedoes run all around the deck.

The vessel is constructed throughout of mild steel, about ¾ inch thick, the plates for the hull proper being galvanized. It will probably be noticed by our readers who turn up the description of the *Viper's* trials that she reached a maximum speed of 26.786 knots, making 386.46 revolutions per minute. They must not, however, overlook the fact that the *Viper* carried then only 26 tons, whereas the *Boa*, as we have already said, carried 44 tons. There can be no question that the latter vessel with a decreased load could attain approximately the same speed as her sister, although her horse-power is no greater and her length and beam are increased.

The vessel ran for the greater part of the time at a nominal half-speed, or thereabouts, between 12 and 15 knots, and at that speed there was absolutely no vibration, and even on the short spurts at higher speeds, which were made when more open water was reached, only a slight tremor was appreciable. This result has, we believe we are correct in saying, been attained without the introduction of any special balancing arrangements other than those secured by a careful proportioning of the weights of reciprocating parts.—*The Engineer*, Sept. 23, 1898.

[BRAZIL.]

On the 18th June the new battle-ship *Marechal Deodoro* was launched from the Chantiers de la Seyne, near Toulon, for this government. The *Deodora* and her sister ship the *Floriano* are small ironclads of only 3162 tons displacement, but in their way they are formidable little vessels. Their dimensions are as follows: Length, 267 feet 6 inches; beam, 48 feet; draught, 13 feet 2 inches. The engines are to develop 3400 I. H. P.,

giving a speed of 14 knots under natural draught and 15 knots under modified forced draught; the boilers will be water-tube, on the Lagrafel and D'Allest system. Protection is afforded by a complete water-line belt of Harveyized steel, 5 feet deep, of which 2 feet is above the water at ordinary draught; the thickness of the upper part of this belt amidships is 14 inches, and of the lower part 6 inches, while the whole belt tapers at the extremities to 4 inches; there is also a 1.5-inch armored deck, extending the whole length of the ship. The two turrets are protected by 8.2-inch plates of hardened steel, and work inside a barbette protected by 7-inch steel, into which lead the armored ammunition tubes, etc. The armament consists of two 24-centimetre (9.4-inch) Armstrongs, mounted in the turrets, one forward and one aft, with an arc of training of 250 degrees; the turrets can be worked either by hand or electricity, while the ammunition hoists are also worked by electricity; there are four 4.7-inch Q. F. guns in small casemates, protected by 2.9-inch armor—one on each beam immediately abaft the fore turret and one on each beam immediately before the after turret, with two 6-inch howitzers, mounted one forward and one aft on the spar deck, and six 6-pounders and 1-pounder Q. F. guns, with two submerged torpedo-tubes. The conning tower is protected by 4-inch armor, as are also all the combings of the openings through the armored deck.

The torpedo cruiser Tamoyo, of 1000 tons displacement, 7000 I. H. P. and 23 knots' speed, was launched from the Germania Yard at Kiel on the 26th May. She is 269 feet long, with a beam of 28 feet 10 inches, and her armament will consist of two 3.9-inch, six 2.2-inch, two 1.4-inch guns (all Q. F.), with two machine guns.—*Le Yacht*.

[CHINA.]

A 35.2-KNOT TORPEDO-BOAT.

A cable dispatch says that the extraordinary record 40.8 miles an hour was made at the second trials of the torpedo-boat destroyer Hai Lung, just built at Elbing, Germany, by the Schichau works for the Chinese government. The runs were made in the open sea between the light-houses at Pillau and Brusterort, which are 19 knots apart. The wind was fresh (five by the scale) and there was considerable sea on. The Hai Lung, according to the *Kölnische Zeitung*, traversed the course several times, the average time for the runs being 32 minutes 28 seconds, which gave a speed of 35.2 knots, or 68 kilometers, or 40.8 statute miles. This exceeds by far any speed heretofore made on the water, surpassing even the best performance of the Turbinia.—*Scientific American*.

[ENGLAND.]

LAUNCH OF H. M. S. OCEAN.

The Ocean, battle-ship, was launched at Devonport on July 5th by Princess Louise, Marchioness of Lorne, in the presence of enormous crowds of spectators. Great interest was taken in the event at Devonport and throughout the neighborhood, and excursion trains were run by the railway companies from various parts of Devon and Cornwall. Twenty-five thousand persons are officially estimated to have entered the dockyard.

The naming ceremony was successfully performed by the Princess, and

she was then presented by Rear-Admiral Carr with a mallet and chisel enclosed in a handsomely carved box which had been made in the dock-yard. Then came a weary and anxious period of waiting. According to the programme the launch should have taken place at 5.30, but it was not effected until twenty minutes past six. The delay was due to the fact that earlier in the day the vessel had begun to slide down. It was found at two o'clock that she had moved $\frac{1}{2}$ inch, and it was then decided to replace the blocks which had been removed in readiness for the launch. The ship then settled down upon the blocks, and when the time came for launching her it was found necessary to split them up. Owing to the rising tide two or three blocks became submerged and could not be removed, and the Ocean cut these up as she passed over them into the water. The cord holding the weights by which the dogshores were to be knocked away was severed by Princess Louise at twenty minutes past six, just as the tide was at its height, and the vessel at once slid gracefully into the water amid the cheers of the thousands of spectators.—*The Engineer*.

H. M. S. AMPHITRITE.

The Amphitrite is 435 feet in length between perpendiculars, but the overhanging stern and the projecting ram make the length over all 463 feet. Her beam over the sheathing is 69 feet, and her moulded depth to the upper deck is 39 feet 9 inches. The mean load draught of the vessel is 25 feet 3 inches, at which draught the displacement is 11,000 tons. The hull of the vessel is constructed of Siemens-Martin steel, the heavy external framing of the bow and stern as well as the propeller brackets and the rudder frame being phosphor-bronze castings. The rudder is of the balanced type, and the stern curved outwards under the water, so as to form a formidable ram; up to a height of about 9 feet above the water line the steel shell of the vessel is sheathed with teak planking and coppered. Two long bilge keels to prevent rolling are also fitted. The vessel's bottom, amidships, is constructed on the cellular principle, the inner skin being carried from the protective deck at one side down and up to the protective deck at the other side. The double bottom is minutely sub-divided into water-tight compartments. By water-tight bulkheads and water-tight flats the vessel is thoroughly closely subdivided. The protection consists of a curved armored deck of steel plating 4 inches thick at the crown, which extends the whole length of the vessel. Under this deck, which is raised in way of the engines, are also placed the steering engines and gear, the capstan engines, the air-compressing machinery, and all the magazines, shell-rooms and torpedo-rooms. The coal bunkers, which have a capacity of over 2000 tons of coal, are arranged along the sides of the boiler-rooms and along the sides of the vessel on the protective deck above the engines and boilers.

The armament of the vessel, as will be seen from the statement, is of a most powerful description. There are sixteen 6-inch quick-firing guns, twelve 12-pounder quick-firing guns, three 3-pounder quick-firing guns, two 12-pounder boat and field guns, and eight 0.45-inch Maxim machine guns. The 6-inch guns are mounted as follows: Two on the fore-castle head, two on the upper deck aft, the remaining twelve being mounted on the broadside in armored casemates constructed of Harveyed steel armor, 6 inches thick. Of these twelve casemates, eight are on the main deck level and four on the upper deck level. The 12-pounder guns are mounted

four on each broadside on the upper deck, two on the upper deck under the forecastle and two right aft on the main deck. The 3-pounder guns are mounted on the boat platform deck. The Amphitrite is fitted with two under-water broadside torpedo tubes, placed under the protective deck in a special compartment forward. The 6-inch guns and 12-pounder guns will be supplied with ammunition through armored tubes, extending from the protective deck to the deck on which the guns are worked. An ammunition passage is arranged on each side of the ship, extending for the whole length of the machinery space below the protective deck. The passage is completely protected by coal on top, sides and bottom, so that the ammunition need never be exposed to gun-fire in its course from the magazines to the guns.

The conning tower is placed forward and is built of Harveyed steel armor 12 inches thick. From it are led voice pipes, telegraphs, etc., down through a forged steel tube 7 inches thick to the protective deck, and forward and aft underneath this deck to the engine-room, torpedo-rooms and steering positions. Above the conning tower is a navigating bridge with chart-room, steering standard, telegraphs, etc., required in the ordinary navigating of the ship. The vessel is fitted with two steel masts. Unlike her larger sister ship, the *Powerful*, these are not fitted with fighting tops, but on the top of the mainmast pole is fitted large semaphore signalling apparatus. There are five steam steering positions, one on the forward navigating bridge, one on the aft bridge, one in the conning tower, and two under the protective deck. Efficient hand gear is also fitted aft under the protective deck.

The vessel is lighted throughout with electricity, there being three dynamos supplying six powerful searchlights and the incandescent lights, which number about 850. The searchlights are placed one in special top on each mast and two on each bridge. The ventilation, both natural and artificial, is most complete; there are four large ventilating steam fans for ventilating the main spaces of the ship, and one electric fan for cabin ventilation. On the deck are arranged two boat-hoisting engines and two coal-hoisting engines, heavy derricks being also fitted for hoisting the boats inboard and over the side. The boats, which are fourteen in number, include a 56-foot steam pinnace and two steam launches, which are stowed on a steel boat deck, extending from the forecastle to the after bridge. The total complement of the vessel, including the admiral's retinue, will be 718 men, for whose comfort every provision is made. The officers' quarters, which include a spacious suite for the admiral, are arranged mostly on the main deck abaft the machinery, the crew and petty officers being accommodated.—*The Engineer*, July 15, 1898.

H. M. S. ALBION.

The battle-ship *Albion*, the launch of which lately was attended by a terrible catastrophe, is a vessel of the *Canopus* class which has been built by the Thames Iron Works and Shipbuilding Company, at Blackwall, to the order of the government. Like others of her class, she is 390 feet long between perpendiculars, 74 feet wide, and will have a draught of water 26 feet, at which her calculated displacement is nearly 13,000 tons. The order for the *Albion* and her sister vessels was given out in July, 1896. The other ships of the class originally ordered are the *Canopus*, built at Portsmouth, the *Goliath* at Chatham, the *Ocean* at Devonport, and the *Glory* at Laird's, Birkenhead. A sixth ship, the *Vengeance*, was

added to the class after the navy estimates for 1897 had been first put forward, the cost of her construction for the year being included in an additional half-million asked for when the shipbuilding vote came on in the House somewhat late in the session. The last-named vessel has been put out to contract with Messrs. Vickers, Sons and Maxim, at their newly-acquired yard, once the property of the Barrow Shipbuilding Company.

According to the official programme the Albion was not to have been launched before July, but circumstances which have been considered of sufficient importance by the Admiralty have hastened the event. As a consequence the ship is in a very unfinished state. Little of the armor is in place, and the casemates are mostly not in position. The belt armor is of 6-inch Harveyed steel and extends over a length of 196 feet, protecting the side for 5 feet below and 9 feet above the water-line. It is backed by 4 inches of teak and has also two thicknesses of $\frac{1}{2}$ -inch plating. At the ends of this protected length are athwartship bulkheads, also of Harveyed steel plates, 12 inches, 10 inches and 8 inches in thickness. These join the two sides of the belt and connect also with the two barbettes which form positions for the principal armament. The arrangement of the armored deck is similar to that now adopted by the Admiralty for battle-ships, the deck being joined at its outer edges to the bottom of the belt, but having transversely sufficient rise to bring the central part 2 feet 6 inches above the water-line. The main and middle decks are also protected by plates $\frac{1}{2}$ inch and 1 inch thick. The 6-inch guns are mounted in casemates in the way now usual for guns of this nature, having 6-inch armor at the sides; whilst inboard they are partitioned off by a double thickness of 1-inch plating. The forward and after casemates are sponsoned out sufficiently to allow a line of fire directly ahead in the case of the forward guns and directly astern in the case of the after guns, the angle commanded in both instances being 120 degrees. The barbettes are armored on the upper parts with 12-inch Harveyed steel plates, the lower tiers of plates, which are behind other armor, being 6 inches thick. For protection of the guns in the barbettes there are 8-inch Harveyed steel shields. The ends of the ships of this design are partially protected by 2-inch nickel-steel plates being worked outside the skin plating from the forward bulkhead to the stem, and from the after bulkhead to the stern. This forms what is practically a continuation of the belt of extended area.

The main armament consists of four 12-inch wire-wound guns of 46 tons each. These will be mounted in pairs in the barbettes upon turntables, and have the now usual "all-round" loading arrangements. There are twelve 6-inch quick-firing guns placed each in a separate casemate, eight being on the main deck and four on the upper deck. There are ten 12-pounders, six being on the upper deck amidships and between the two 6-inch guns on each broadside, whilst four are placed on the main deck, two right forward and two right aft. There are also six 3-pounder Hotchkiss guns, these being distributed between the two military tops on each of the two masts. There are also two 12-pounder guns for boat and landing purposes, eight 0.45-inch Maxim automatic guns and six howitzers. The torpedo tubes are submerged and are four in number, two being well forward and two aft. They are for 18-inch torpedoes, of which 14 will be carried for firing from the ship, whilst five 14-inch torpedoes will be supplied to be launched from the dropping gear fixed to the steam pinnaces.

The machinery is being made by Messrs. Maudslay, Sons and Field, of

Lambeth. The twin-screw engines are of the usual triple-expansion type, the cylinders being 30 inches, 49 inches and 50 inches in diameter, the stroke being 4 feet 3 inches. At 108 revolutions per minute, the horse-power developed is estimated to be 13,500, which corresponds to a speed of $18\frac{1}{2}$ knots. The high and intermediate pressure cylinders have piston valves, the low-pressure cylinder having flat slide valves. All are driven by double eccentrics and double bar links. Each cylinder is supported by four columns of H-section standing on cast-steel main bearing frames. The same contractors are supplying a good deal of the auxiliary machinery, including feed pumps, compressing machinery for supplying air jets to the furnaces and compressed air for other purposes, hot-well pumps, fire and bilge pumps, fans, air compressors, electric-light engines, steering engines, etc. The boilers are of the Belleville type, having economizers, as in the Diadem's boilers. It may be remarked that these are the first British battle-ships in which it has been decided to put Belleville boilers. There are 20 of these boilers, but only two chimneys. The boilers are arranged in three groups and are fired fore and aft. The boiler pressure is to be 300 lbs. per square inch, but this will be reduced to 250 lbs. at the engines by the reducing valves usual with Belleville boilers. The total heating surface will be 24,155 square feet for the large tubes of the boilers proper and 11,560 square feet for the smaller tubes in the economizers. The total weight of main and of auxiliary with water in boilers, etc., is estimated at 1290 tons.

It will be seen from the above that the Albion is not so powerful a ship on paper as the vessels of the preceding class, of which the Magnificent was the first launched. In the first place, she is about 2000 tons less displacement, and her armored belt is not so thick by 3 inches, is over 100 feet shorter, and 1 foot less depth. It is said, however, that improvements in the manufacture of armor plating have resulted in giving an equal resistance for the modern 6-inch belt as was possessed by the 9-inch armor of the Magnificent, although, it must be remembered, the latter was of Harveyed steel. The new ship has, however, the additional protection at the ends, which will be good at anything like close range against light projectiles only. The barbettes of the Canopus class have also 12-inch armor in place of the 14-inch of the Magnificent. If we compare the thickness of armor with that of the Royal Sovereign we find a still greater disparity, for the latter ship had an 18-inch belt, but that was not Harveyed steel plating. The four guns of the main armament are of the same weight in both the Magnificent class and the Canopus class, a fact which must be put to the credit of a smaller ship; and the same thing may be said of the 6-inch quick-firers and their case-mates, of which 12 are provided in each design; but the lighter guns are more numerous in the older design, there being sixteen 12-pounders.

The mounting of the 6-inch guns at either end of the battery, to which reference has already been made, gives the Canopus class a very powerful bow or stern attack. The two 46-ton guns in each barbette have been estimated to discharge, within the space of five minutes, eight rounds, the energy of which would be 264,160 foot-tons. The four 6-inch quick-firers at the ends of the battery, on the upper and main decks—which, as stated, can be trained in a line parallel to the keel—would fire 25 rounds each in the same time, and that would add a striking energy of 335,600 foot-tons to the total, so that two 6-inch guns are more than equal in this respect to the guns of the main armament. The two 12-pounder quick-firers which could be brought to bear right ahead or astern would

fire about 75 rounds each in the five minutes, and that would add another 63,450 foot-tons. This would bring the total energy of fire right ahead or right astern to 663,210 foot-tons, which is considerably in excess of the *Magnificent's* power of attack in the same direct lines. Naturally, the broadside fire would not show the same preponderance for the later design, as the advantage is obtained only in the line of fire directly ahead or astern by the sponsoned mounting of the four 6-inch guns at each end of the battery. The weight of the 12-inch projectile is 850 lbs. and that of the 6-inch projectile is 100 lbs.

In regard to engine power, the *Canopus* class have the advantage, their estimated power being 13,500 indicated horse-power, which should be compared with the originally estimated 12,000 power with forced draught of the *Magnificent*, the computed speed of the latter having been 17½ knots. The *Canopus* class are therefore put down at a knot faster, and we believe 1000 extra horse-power was added to the legend when, after the original designs were got out, it was decided to compound the *Belle-ville* boilers, or fit them with what are known as economizers. The full coal capacity of the *Magnificent* is 1800 tons, or 100 tons less than that of the new ships.

Naturally it is not possible to make an accurate comparison of different designs without having knowledge of all the elements, and this complete information is known only at the Admiralty. We may, perhaps, safely conclude that no great sacrifice has been made of essential military features to secure the advantages that the new ships undoubtedly possess. Sir William White, therefore, appears to have even surpassed his former efforts, and Sir John Durston is likewise to be congratulated, for the additional power attained is one of the conspicuous features of the class.

There is one other feature of design to which reference may be made. Profiting by a melancholy experience, the style of ram bow applied to recent vessels has been framed on new lines. It is brought nearer the surface than was usual formerly, and is altogether of a more substantial nature, having more the appearance of the fore end of a bottle-nosed whale than the "spur" of the earlier ironclads. Being near the surface and of such substantial proportions would lead, one would think, to an appreciable addition to the wave-making resistance; but, on the other hand, the hole that it would make in an adversary would put the matter of further combat beyond the pale of reckoning. This massive ram has additional support to that formerly given in designs by the 2-inch bow armor of nickel steel, web frames, the armored deck, and a platform deck associated with a stiffening of steel 2 inches thick.

It is an interesting fact, which has been brought to our notice by Mr. J. M. Macrow, the naval architect who has for so many years been the chief professional officer at the Thames Iron Works, that on the slip from which the *Albion* was launched last Tuesday, the first iron war vessel built for the Royal navy was constructed 50 years ago. This was the *Vulcan*, a sister ship to the *Simoon* and the *Megara*. She was designed as a steam frigate, but when well advanced it was determined that iron was not a suitable material to withstand shot and shell, so the *Vulcan* was transformed into a trooper. In the present day engineers may be apt to question the wisdom of the committee of naval officers who arrived at this decision, but it must be remembered that there is a vast difference between the iron skins of those days and the *Harveyed* plates of the *Canopus* class, or even the ordinary steel plates of to-day. As between the wood and iron construction of that era the naval officers

had common sense on their side. The Vulcan was originally engined by Rennies, having four-cylinder engines $49\frac{1}{2}$ inches in diameter, the boiler pressure being 8 lbs. per square inch and the horse-power 793, the speed being $9\frac{1}{2}$ knots. These engines were replaced by a pair of two-cylinder engines by Maudslay, the diameter of each being 64 inches, the steam pressure 10 lbs., and the horse-power 857, but the speed remained much as before, in spite of these advances.

We do not propose referring at any length to the sad accident by which so many lives were lost through the washing away of a bridge or raised gangway, caused by the wave from the launch. At the time of writing full details are not to hand, but these will be found in due course in the daily press. At present it would seem that the only persons to blame were the unfortunate people who put themselves, in spite of warning, in so dangerous a position.—*Engineering*.

H. M. S. SALAMANDER.

Her Majesty's cruiser Salamander has just completed a series of official steam trials in the English Channel, off Plymouth harbor, to test the efficiency of her new water-tube boilers. In addition to the boilers, a complete set of auxiliary machinery has been fitted, consisting of four forced-draught fans, 6 feet diameter, driven by specially designed engines; two main feed pumps and two auxiliary pumps, with steam cylinders 9 inches diameter, pumps $6\frac{1}{2}$ inches diameter, with a stroke of 9 inches, of the vertical duplex type—Mumford and Anthony patent—and four specially designed feed-water regulators, for the purpose of automatically insuring a constant and regular supply of feed-water to the boilers, also the joint patent of Mr. Mumford and Mr. Anthony. These we have fully described in the impression referred to above. The boilers, of which there are four, have each 2000 square feet of heating surface and 45 square feet of grate surface. They were designed to develop collectively 3500 horse-power under forced draught. The trials passed off in a most satisfactory manner, not a hitch occurring. On the eight hours' trial under natural draught the indicated horse-power developed was 2575. On the full-power run of three hours' duration the horse-power developed was 4114—far in excess of the specified amount; this was obtained with an air pressure in the stokeholds of 2.6 inches. The vessel attained a speed of twenty knots.—*The Engineer*, July 15, 1898.

THE STEAM TRIALS OF H. M. S. EUROPA.

We gave in our issue of June 10 an illustration, with complete description, of the machinery of the first-class cruiser Europa, built and engined by the Clydebank Engineering and Shipbuilding Company, Limited, Clydebank, and supplementing that description we now give in tabular form an analysis of the important series of trials which the cruiser has just passed through. There were, in addition to the usual contract trials, tests to determine the full capabilities of the Belleville boiler under a moderate system of forcing. There were thus five trials, three of them of 30 hours' duration; and yet the series of steaming trials, which also included independent speed runs, were made within the minimum possible time, which is the best suggestion that everything went well. Indeed, no warship has ever gone through such a programme in such a short time with results so satisfactory, and Sir John Durston, K. C. B., the engineer-

in-chief of the navy, and Mr. John G. Dunlop, the engineering director at Clydebank, are to be congratulated.

The Europa, it may be said, is a first-class cruiser 435 feet long, 69 feet 6 inches extreme breadth, and at 25 feet 3 inches draught displaces 11,000 tons. She has a protective deck 4 inches thick right fore and aft, and her guns are either in casemates, or have nickel-steel shields. Her armament consists of sixteen 6-inch quick-firing guns, fourteen 12-pounder quick-firing guns, three 3-pounders, and eight Maxims, with two submerged torpedo-launching tubes. The engines are of the triple-expansion type, with four cylinders arranged in couples for balancing, the diameters being 34 inches, 55½ inches, 64 inches and 64 inches respectively, with a 4-foot stroke. The cooling surface is 17,500 square feet. There are 30 boilers of the Belleville type, with economizers. The grate area is 1450 square feet, the heating surface in the generators 29,620 square feet, and in the economizers 10,980 square feet, making a total of 40,600 square feet. These particulars will assist the reader in following the results given in the table. The ship belongs to the same class as the Diadem, whose trials we fully reported in January and February.

EUROPA: PARTICULARS OF TRIALS.

Date of Trial.....	June 1 and 2, 1898	June 3 and 4, 1898	June 7 and 8, 1898	June 10 and 11, 1898	June 12 and 13, 1898
Description of Trial.....	30 hours' coal consumpt'n at 3300 H. P.	30 hours at 12,500 H. P.	8 hours	30 hours' coal consumption with 24 boilers	4 hours at 12,500 H. P.
Heating surface in use.....sq. ft.	13,500, 10 boilers	40,550, 30 boilers	40,550, 30 boilers	31,700, 24 boilers	31,700, 24 boilers
Grate " " " " " " " "	491	1460	1460	1243	1243
Ratio of grate to heating surface	1 : 27.53	1 : 27.73	1 : 27.73	1 : 27.73	1 : 27.73
Steam pressure in boilers.....	112	205	279	261	261
Air pressure in stokeholds.....	.25 vacuum in smoke- boxes			.07	
Mean revolutions per minute.....	65.4	103.8	119.4	106.7	106.7
Mean indicated horse-power.....	3302	12,739	17,070	12,666	12,666
Coal burnt per indicated horse-power per hour..	2.24	1.04	Not taken	2.02	2.02
" " square foot of grate per hour	15	16.9	"	22.38	22.38
Indicated horse-power per square foot of grate..	6.78	8.71	11.63	11.08	11.08
Heating surface per indicated horse-power.....	4.09	3.18	2.38	2.5	2.5

The coal used was very inferior owing to the coal strike, and had been exposed to the weather without shelter in the dockyard for a long period. The coal consumption would otherwise have been lower.

It will be seen that the first trial was at one-fifth full power, when 10 boilers were in use, and here 3302 indicated horse-power was got for 65.4 revolutions, while the coal consumption was 2.24 lbs. per horse-power hour, which is satisfactory for this low power, especially in view of the fact that the coal used throughout the trial was very inferior, owing to the Welsh coal strike, a fact which should be carefully noted when comparing results. The second trial, also of 30 hours' duration, was at about 75 per cent. of the full power, with all the boilers in use, while the third was the full-power trial, of eight hours' duration, both of which gave satisfactory results alike in respect of power and consumption. The more important trials, however, are those given in the fourth and fifth columns of the table, when only 24 out of the 30 boilers were in use. These were extra trials undertaken at the request of the Admiralty authorities. In the one case the engines were required to develop 75 per cent. of the full power, and in the other the full power, or as much as possible. In the former case the power was got with only 0.07 inch of

air pressure in the stokeholds, and with a consumption of 2.02 lbs. of inferior coal. On the four hours' trial the boilers, with what used to be regarded as natural-draught conditions—an air pressure less than $\frac{1}{2}$ inch—gave 14.25 indicated horse-power per square foot of grate, and yet only consumed 1.91 lb. per horse-power hour, although the rate of consumption was 27.23 lbs. per square foot of grate per hour. This result will be regarded as very favorable, indicating, as it does, that the ships of this class have that reserve of boiler power for full speed which does not characterize all the ships of the navy. It shows that two or three of the boilers may be placed *hors de combat* without affecting the speed of the ship.

The vessel also ran a series of trials at progressive speeds on the measured mile at Stokes Bay and over the deep-sea course from Dodman to Rame Head. The full speed of $20\frac{1}{2}$ knots was easily got with the ship at full draught. On the trial of June 13 also the speed was tested by two runs over a 24-mile course, and showed a speed of 20.8 knots. The results confirmed those got with the Diadem, and added one more to the long list of successes by Sir William White, the Director of Naval Construction. In this connection reference may be made to the appointment of Mr. W. J. Luke, for several years an active member of Sir William's staff, as naval architect for the Clydebank Company. Mr. Luke, who was a distinguished student of the Naval College at Greenwich and, later, lecturer on naval architecture, has been, as an assistant constructor, closely identified with the design of first-class cruisers and the Queen's yacht, and there is a certain appropriateness in the last ship passed through his hands being the production of the company, of whose staff he is now an important member.—*Engineering*.

THE STEAM TRIALS OF H. M. S. NIOBE.

The accompanying table gives an abstract of the results of the official contract trials of H. M. S. Niobe, built and engined at the Naval Construction Works of Messrs. Vickers, Sons and Maxim, Limited, at Barrow-in-Furness. The Niobe belongs to a class of which eight have been ordered, and the Amphitrite, launched lately from the same works, is also one of the eight. The Diadem and Europa, which have also passed through their trials, are also of the same class. There is no need to describe the ship, which is of 11,000 tons displacement; but it may be said that the engines are of the triple-expansion type with two low-pressure cylinders, and with four cranks. The high-pressure cylinder is 34 inches; the intermediate, $55\frac{1}{2}$ inches; and the two low-pressures each 64 inches; with a stroke of 48 inches. There are 30 Belleville boilers, and the designed full power was 16,500 indicated horse-power. The contract conditions, which were easily excelled, were a trial of 30 hours' duration at one-fifth full power, a 30 hours' trial at 75 per cent. of the full power, and an eight hours' full-power run. The results of all three trials are appended:

Results of thirty hours' coal consumption trial at 3310 indicated horse-power, and 12,500 indicated horse-power, and eight hours' full-power trial at 16,500 indicated horse power:

	3300 I.H.P. Stbd. Port.		12,500 I.H.P. Stbd. Port.		16,500 I.H.P. Stbd. Port.	
Mean steam in boilers.....	200		258		263	
Mean steam at engines.....	147		220		235	
Mean vacuum	28.1	28.1	27.4	27.6	26.9	27.0
Mean revolutions	70.2	70.0	107.4	107.6	118.0	117.0
Mean pressure in cylinders	H. P.....	30.8	37.8	88.0	86.9	106.6
	I. P.....	14.6	12.8	35.4	36.5	37.7
	L. P. ¹	5.4	5.5	12.8	13.3	16.8
	L. P. ²	5.1	5.0	12.2	12.8	16.0
Indicated horse-power	H. P.....	477	583	2078	2065	2771
	I. P.....	603	525	2233	2303	2614
	L. P. ¹	299	299	1073	1114	1556
	L. P. ²	280	275	1024	1071	1473
Total indicated horse-power.....	1659	1682	6408	6553	8414	8420
Gross total indicated horse-power.	3341		12,961		16,834	
Coal per indicated horse-power...	1.77		1.55		1.66	
Speed by log	12.3		19.33			
Speed over measured course.....			19.27		20.507	

The coal consumption comes out most satisfactory in all three trials, and particularly in the trial at 75 per cent. full power, which is supposed to be the most economical rate of steaming for the design of engine adopted. This 1.55 lbs. per horse-power hour, of course, includes the consumption for all the auxiliary machinery on board, without rating the power of these engines, which are usually very expensive in fuel. The engines ran during this trial, as with the others, with remarkable steadiness. The variations in the total power were confined within almost the limits of error, and during the night and morning watches the variations were between 12,997 and 13,170 indicated horse-power. The revolutions continued very steady between 107 and 108. Indeed, the whole machinery worked with all the steadiness and with the little attention which characterizes the tramp steamer rather than the warship. The weather was exceptionally fine and the trials followed each other as soon as the coaling arrangements permitted. The speed on the 12,500 indicated horse-power and full-power trials were taken on the measured distance between Rame Head and Dodman Point.—*Engineering*, July 9, 1898.

[FRANCE.]

THE FAST CRUISER CHATEAURENAULT.

This fine vessel was launched on the 12th May last; she was constructed by the Forges et Chantiers de la Seyne, and has a displacement of 8018 tons. From the first the intention has been to avoid giving the ship the man-of-war appearance so prominent in the American cruisers *Columbia* and *Minneapolis*, particularly in the form of the bow and stern. The profile adopted (it is easily understood to what end) is strictly that of the mail steamer. The straight stem, long run, overhanging stern and pole masts all combine to give the ship the pacific aspect of a large Atlantic greyhound. As regards sea-going qualities, the straight stem slightly

inclined inboard, in the opinion of seamen, is an advantage for a ship destined to maintain a high speed, if necessary, against a head sea. The disadvantage which the form of bow has in limiting the depression of the bow gun has been overcome, to a certain extent, by lowering the upper deck forward on the Chateaufrenault. This allows of the gun being placed far enough aft to obtain a solid base without compromising the strength of the structure forward by the reactions of firing under a depression of about 5 degrees, which is considered sufficient. The rudimentary pole masts are fitted with the necessary signal apparatus, and two fixed platforms at their lower parts for electric light projectors. There are 4 funnels as on the Columbia; the casings do not extend higher than within about 5 metres of their tops, thus saving useless top weights and gaining stability. In her cross sections the upper works "fall home" somewhat. The ship has a forecabin and poop invisible from the exterior, the lines of the bulwarks being carried in an unbroken line fore and aft. During her construction the Marine Board decided to cover in the space between the forecabin and poop by a shelter deck, very light and completely free, which should serve as a roof to the upper deck, permit the crew to sleep under it, and at the same time form a promenade deck, altogether a very elegant and relatively peaceful arrangement, very appropriate to the special mission the Chateaufrenault is designed to fulfil in time of war. The dimensions of the Chateaufrenault, as compared with the Minneapolis, are as follows:

	CHATEAUFRENAULT.	MINNEAPOLIS.
Length over all.....	139.45 m. (452 ft.)	
Length between perpendiculars..	135 " (442 ft. 10 in.)	125.08 m. (412 ft.)
Beam.....	17 " (55 ft. 9 in.)	17.72 " (58 ft. 2 in.)
Draught of water aft.	7.40 " (24 ft. 6 in.)	7.10 " (23 ft. 6 in.)
Displacement	8,018 tons	7,505 tons on trials 8,133 " maximum
I. H. P.....	23,000	21,000
Full speed, forced draught.....	23 knots (estimated)	22 knots (estimated) 23.7 " on trials
Coal bunker capacity	2,100 tons	1,518 tons 1—203 mm. (8-in.)
Armament	{ 2—164.7 mm. (6.4 in.) Q. F. { 6—138.7 " (5.5 in.) Q. F. { 10—47 " (3-pdr.) Q. F.	{ 2—152 " (6-in.) Q. F. { 8—102 " (4-in.) Q. F. { 12—57 " (6-p.) Q. F. { 4—37 " (1-p.) Q. F.

The artillery of the American ship is therefore superior as regards the number of guns, but on the other hand the Chateaufrenault is better provided with stores and coals. This would appear to be preferable for a ship of which the first requirements are speed and radius of action, and the latter in the case of the French ship is about 10,500 miles at 12 knots. In fact, such as it is, the artillery of our fast cruisers appears to be sufficient to give them the advantage over any auxiliary armed cruiser, and their speed to protect them against the cruisers of any enemy superior in armament and protection. The armament of the Chateaufrenault is disposed as follows: The two 164.7-millimetre guns are on central pivot

mountings, one on the poop and one on the forecastle; six 138.7-millimetre, of which four are in redoubts on the upper deck forward and aft, and two on sponsons in the central part of the ship; while ten 47-centimetre are distributed above the redoubts and at the ends of the ship. All these Q. F. guns are served from magazines placed directly under them, the hoists being worked, as we shall see later, either by hand power or electricity. As regards speed, we know that the American cruisers have not fulfilled the expectations formed of them after their brilliant trial performances. For reasons which we have frequently explained in this journal, we are better secured in France against these discrepancies in trial and actual service speeds. We can, therefore, confidently hope that the Chateaufort will have in reality a speed superior to that of any foreign ship of the same class. It would cause no surprise either if the estimated speed of 23 knots should be sensibly exceeded in the trials. The constructors of Les Chantiers de la Seyne are thoroughly capable, and it is satisfactory to know that the lines of the Chateaufort have been studied by M. Lagane, so that we may be convinced their fineness and perfection will contribute to the highest possible success in the matter of speed. The propelling apparatus consists of three triple-expansion engines, each with its own propeller; the minimum power to be developed being 23,000 I. H. P. at about 124 revolutions per minute. The evaporative apparatus, which was originally intended to comprise boilers of the Lagrafel-d'Allest type, will now be constituted of fourteen Normand-Sigaudy boilers with small tubes, divided into four unequal groups, three of four boilers each, and one of two right forward. The engine and boiler-rooms will occupy about half the total length of the ship; the total weight is about the same as that of the Minneapolis, 1950 tons. The marked difference in the weights forming the displacement of these two ships lies in the protection and coal supply. The armor protection in the Chateaufort is to that of the Minneapolis as 6 to 10; the coal supply, on the other hand, of the Chateaufort is nearly double that of the other ship. This comparison confirms the impression that the French ship is more truly a corsair than cruiser in the military sense of the word than is her American contemporary. The zinc boxes in the compartments of the cofferdams have been omitted by the order of the board, and the cofferdams modified in consequence. The turtle-back armor deck, which is 2.5 inches thick, has its centre about 0.95 metre above the water-line, sloping at the sides to 1.40 metres below it. The guns are protected by fixed redoubts and revolving shields, both 2 inches thick, as provided in the design. With the exception of the boat-hoisting gear, consisting of four steam winches of 3000 kilogrammes, everything is worked by electricity, or by hand-power in case of injury, including guns, ammunition, steering-gear, etc. The electrical energy is furnished by four dynamos, of 80 volts 600 ampères, of which one can be held in reserve, the other three being quite capable to supply all services. There are twelve electric hoists for ammunition, distributed as follows: Two for the 164-millimetre, six for the 138.6-millimetre, and four for the 47-millimetre guns. The electric steering gear can be worked indifferently from the bridge, conning tower or central position. There are also three electrical Rateau ventilators, three Peruisse order transmitters from the conning tower to engine-rooms, and six projectors, controllable at a distance. These projectors are arranged, one on the platform on each mast, four surface-sweeping arranged lozenge-fashion; those on the beam

and the one forward are on a moving carriage, the one aft and those on the masts of fixed pedestals. The dynamos also supply the current for the bow and position lights, lamps and reflectors for working at night, and about 450 incandescent lamps, from 10 to 60 candle-power each. We see, therefore, that there is a very large application of electrical power on board the Chateaurenault. It is hardly necessary to add that in the matter of accommodation and comfort there is absolutely nothing to be desired; the ventilation has been well studied, and excellent conditions of habitability may be confidently expected. It was intended that the Chateaurenault should carry a rear-admiral and staff, but the idea has been abandoned. She will carry 2 superior officers, 15 junior, 10 cadets, 50 petty officers, 114 stokers, mechanics, etc., and about 500 bluejackets. The ship is to be completed by the 8th July, 1899, at Toulon, having been laid down on 23rd May, 1896. She was launched with her protective deck completed and her upper works well advanced. She will be completed by Les Chantiers de la Seyne with all dispatch, and her construction will be a great honor to the firm.—*Royal United Service Institution.*

ENGINES OF THE FRENCH ARMORED CRUISER CHANZY.

The French armored cruiser Chanzy was launched in 1894 and was completed some two years later. She belongs to the Amiral Charner type, and the group comprises four ships—the Charner, Bruix, Chanzy and Latouche-Treville—the last named having been launched in 1892. The Chanzy is built wholly of steel, and is 110 metres long (360 feet 10 inches), 14 metres beam (45 feet 11 inches), and 6 metres (19 feet 8 inches) draught. The displacement is 4750 tons, and the indicated horse-power of the engines is 8300. There are two screws, and the speed attained is 19 knots. The armored protection of all four vessels is similar, and consist of a belt of 95 millimetres (3.74 inches); turrets protected with the same thickness; and an armored deck of 50 millimetres (1.97 inch). The armament is as follows: Two 19-centimetre (7.47 inch) guns; six of 14 centimetres (5.51 inches) quick-firing; four 65-millimetre (2.56-inch), also quick-firing; four similar guns of 49 millimetres (1.85 inches), and six machine guns.

The main engines, which were built by Messrs. Schneider & Co., of Creusot, are horizontal three-cylinder triple-expansion, each driving a propeller. The principal dimensions are the following: Diameter of high-pressure cylinder, 0.800 metres (31½ inches); diameter of mean-pressure cylinder, 1.200 metres (47½ inches); diameter of low-pressure cylinder, 1.900 metres (74½ inches); stroke, 0.9 metre (35½ inches).

Each engine is provided with a condensing installation, consisting of a wrought-brass tubular condenser, two single-acting vertical air pumps, and a centrifugal circulating pump. The pumps are worked by a separate engine.

All the slide valves are cylindrical; the high-pressure cylinder is fitted with one, while the mean and low-pressure cylinders have each two. The steam distribution motion is on the Marshall system.

The reversing gear, which is worked by hand and by steam power, allows of regulating the degree of admission of steam in the cylinders. The pistons are of cast steel and conical in shape. The foundation plates on which rest the crankshaft bearer-blocks are also of cast steel; the bearer-blocks are, moreover, fitted to the cylinders by forged-steel cross-bars. All the crankshafts, intermediate and propeller shafts are hollow,

tainty as to the thickness of those in the Oden type; probably they do not exceed 8 inches, and may be less. They are apparently not of hardened steel. The smaller guns of the Haarfragre are all behind shields, while those of the Oden type are in a 5-inch armored battery. As regards speed, the Haarfragre has a continuous sea speed of about 14 knots; according to her officers her trial speed was 17.2 with natural draught. She may therefore be set down as a swifter vessel. Her coal supply is 200 tons, that of the Swede 300 tons. Both, of course, are low freeboard ships. It is difficult to decide between the vessels as to which is the better. It has already been stated in *The Engineer* that officers of the Haarfragre told ours that the Elswick design gave the ship four 4.7's only, and that two extra guns were added by request of the Norwegian Admiralty. The crews of these extra guns practically work underneath the men at the 12-pounders, unless their guns are trained directly on the broadside. It is possible to conceive of grave inconvenience from this. The battery of the Njord, sister to the Oden, must have her guns very crowded indeed. However, the new 4.7's as mounted on top of our Alexandra's battery are more crowded together still, though that ship has the advantage of a larger beam. There is no doubt that a single shell would clean out the Njord's battery; that of the Haarfragre, being in the open air, would be less likely to suffer so heavily from a solitary shell.

Turning to other Swedish ships, the Svea has had her 6-inch breech-loaders replaced by 4.7 quick-firers. The old monitor John Ericsson has been reconstructed, the old turret being converted into a barbette by opening the top. Inside this two 6-inch guns are mounted behind a thick shield. The old armored gunboats are mostly in hand for reconstruction, the Ulf and Berserk being already completed. The old gun has been replaced by a 4.7 quick-firer. With their light draught these little ships might be exceedingly useful. There is from 14 inches to 17 inches of laminated iron armor over this gun; it is probably fairly safe against anything less than a 10-inch gun. The catchers Ornen, Jacob, Bagge, Clas Horn and Clas Uggla are either ready for sea or nearly so.—*The Engineer*.

[UNITED STATES.]

LAUNCH OF THE ILLINOIS.

In the launch of the battle-ship Illinois at Newport News, October 4, the Navy has the beginning of an important addition to its strength. The launch was successful in every way, Miss Leiter saying in a clear and ringing voice, "I christen thee Illinois," as she swung a bottle of champagne against the battle-ship. The Illinois has a length on load water-line of 368 feet; beam, extreme, 72 feet 2½ inches; draught on normal displacement of 11,525 tons, 23 feet 6 inches; maximum displacement, 12,325 tons; maximum indicated horse-power (estimated), 10,000; probable speed, 16½ knots; normal coal supply, 800 tons; full bunker capacity, 1400 to 1500 tons; complement of officers, 40; seamen, marines, etc., 449. These data show that the necessity for speed which the experience of this war has forced upon us was not appreciated fully when the Illinois was designed. She represents the highest development of what even now must be considered the old American notions.

In armament she is strikingly powerful. Four 13-inch guns in two

turrets, placed in the centre line; fourteen 6-inch R. F. guns, sixteen 6-pounder, four 1-pounder, two Colt and two field guns, make a heavy battery. She will carry four torpedo tubes. The 13-inch guns have an arc of fire of 270 degrees and the 6-inch an arc of 90 degrees on the broadside, and those on the upper deck have a direct fire ahead and astern.

The armor belt, which extends from the stem to abaft the after turret, is to be 16½ inches thick at the top and 9½ inches thick at the bottom, tapering to four inches at the stem. The diagonal armor is 12 inches thick. The protective deck is carefully designed, being 2¾ inches on the flat, 3 inches on the slope forward and 4 inches abaft the turrets. The turret armor is 17 inches front and 15 inches back and sides. The barbettes for the turrets will be 15 inches on the front and 10 inches on the rear and sides, and the casemates will have 5½-inch armor. Two conning towers are provided, one 7 by 11 feet, 10 inches thick, and one 6 feet diameter and 6 inches thick.

The height of freeboard forward is 20 feet and at the stern 13¾ feet. The floor of the pilot house is 44 feet high. The sight holes in the conning tower are 34½ feet above the water. The forward 13-inch guns will have an elevation of 26½ feet, the after guns 19 feet, the 6-inch guns from 15 to 22½ feet, and the 6-pounders from 30 to 40½ feet above water. Smaller guns are mounted in the military tops at heights of from 59 to 79 feet. All these dimensions indicate both seaworthiness and great fighting range. Four searchlights are provided.

There will be two sets of triple-expansion, twin-screw engines, in separate water-tight compartments. The indicated horse-power will be about 10,000, with 120 revolutions per minute; stroke, 4 feet. There are eight single-ended cylindrical boilers, each 15½ feet in diameter by 9 feet 11¼ inches long, having a total grate surface of 685 square feet, with 21,200 square feet of heating surface; pressure, 180 pounds. These boilers are placed, two each, in four separate water-tight compartments. The smoke pipes are two, and stand abreast of each other.

The first keel plate of this vessel was laid February 10, 1897, not quite twenty months ago, and the work completed to date is between 53 and 54 per cent. The price was \$2,595,000, and the date of completion is announced as October 5, 1899. Her sister ship, the *Wisconsin*, will be launched from the Cramps' shipyard next month, and another, the *Alabama*, will follow from the Union Iron Works, San Francisco.—*Army and Navy Journal*, Oct. 8, 1898.

Obituary.

HERMAN G. DRESEL.

It seems fitting that the pages of the *Naval Institute* should render some tribute to the memory of one who for a number of years gave thoughtful and conscientious attention to its issues. It seems further fitting that this tribute should be more than a mere recount of routine services, for in the death of Lieutenant Herman G. Dresel the Navy of the United States has not only lost a sound-thinking man, but also a man of action, one who only lacked the opportunity to prove himself both brave and daring.

It was the good fortune of the writer to have been thrown with the deceased for nearly two whole cruises and a year or so of shore duty. Intercourse only served to increase a love for him as a man and an admiration for his intellect. Accomplishments so varied and withal so modestly hidden are rarely found in any one individual. Be the subject art, science, sport or technical knowledge of his profession, he was equally at home.

He had a conservative of approaching a subject which quite deceived the listener as to the degree of his familiarity with it. Should his listener prove well found, however, he jumped quickly from an attitude of inquiry to one of mastery of the subject and defined his position in strong and concise arguments. His manner on these occasions was vigorous, aggressive, but withal considerate, and no one could engage in a serious discussion with him without becoming better informed or forced to admire the fence of his antagonist.

As a musician he quite outclassed the skilled amateur; as a natural scientist, he was an acute observer and a well-equipped collector; as a linguist, he spoke two foreign languages well and was conversant with two others; as an instructor in mathematics, he was noted for his thoroughness and intense interest in his

work; as a sportsman he was both skillful and enthusiastic, while his conspicuous activity in athletic matters brought him close to those who have followed the career of the Navy in such matters; his association with the Naval Institute covered one of the most successful periods of its career; his reputation as an officer was of the best.

He was ambitious for service where his courage could be proven; he was restless under restraint; he never could tolerate a conservative spirit in such matters. He was chivalric, high toned, generous, and his untimely death must be attributed to that fierce war which the elements of high-strung natures frequently wage with one another, especially at times when ambition and high hopes seemed to have failed of recognition.

No profession can afford to lose so versatile a man, especially when the essentials of that profession are so well met, and when death called upon us, among the living, to erase the name of Herman Dresel from the Navy rolls, we silently registered in our minds the name of another victim to that stagnation in naval matters which has so often subordinated the strong to the weak, the sensitive to the indifferent, the genius to the commonplace.

Affections are not altogether out of place even in a warlike profession, and a man who can arouse real affection, even among a few of his associates, must be regarded with that consideration which is due to men of mental power, and in rendering this incomplete and necessarily hasty tribute to the memory of a dear friend and shipmate, I confess my thorough love for him as friend and companion, my admiration for him as an officer, gentleman and scholar.

C. H. HARLOW, Lieutenant, U. S. Navy.

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ment of Armor during the Years 1893-98. Q. F. Artillery-fire. Observations on Mr. Kinglake's Narrative of the Bombardment of Sebastopol in April, 1855.

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JUNE 24, 1898. The Destruction of the U. S. Battle-ship Maine. Messrs. Schneider & Co.'s Works at Creusot. Armor Plates. Shipbuilding and Shipping in Japan.

JULY 1. The Steam Trials of H. M. S. Europa. The Destruction of the U. S. Battle-ship Maine.

JULY 8. Messrs. Schneider and Co.'s Works at Creusot, No. XXIV. The Defenses of Hong Kong. The Steam Trials of H. M. S. Niobe. The Destruction of the United States Battle-ship Maine. Boiler Explosion at Bradford.

JULY 15. Messrs. Schneider and Co.'s Works at Creusot, No. XXV. The Argentine Cruiser General San Martin. Electric Launch for the Russian Government. Safety at Sea. The Destruction of the United States Battle-ship Maine. Criticism of the Navy. The Whitehead Torpedo.

JULY 22. Messrs. Schneider and Co.'s Works at Creusot, No. XXVI. Naval Machinery. Submarine Telegraph Enterprise.

JULY 29. Messrs. Schneider and Co.'s Works at Creusot, No. XXVII. The Navy Programme. An Old Warship.

AUGUST 5. Messrs. Schneider and Co.'s Works at Creusot, No. XXVIII. Reserves for the Royal Navy.

AUGUST 12. Messrs. Schneider and Co.'s Works at Creusot, No. XXIX. Submarine Telegraph Property. The Phillipine Islands. The Cost of Armor.

AUGUST 19. The Hospital Ship Solace.

AUGUST 26. Messrs. Schneider and Co.'s Works at Creusot, No. XXX.

SEPTEMBER 2. Messrs. Schneider and Co.'s Works at Creusot, No. XXXI. Barbette Carriage for the U. S. 10-inch Breech-loading Rifle. Willard Water-tube Marine Boiler.

SEPTEMBER 9. Messrs. Schneider and Co.'s Works at Creusot, No. XXXII.

SEPTEMBER 16. Engines of the French Protected Cruiser Chanzy.

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OCTOBER 7. Messrs. Schneider and Co.'s Works at Creusot, No. XXXV. The French Naval Manœuvres of 1898. Collisions at Sea. Naval Engineers and the Efficiency of the Navy. Safety Valve and Gate Valve.

OCTOBER 14. Messrs. Schneider and Co.'s Works at Creusot. The Erosion of Gun Tubes.

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JUNE 24, 1898. The Jane Naval War Game at the United Service Institution. The Launch of H. M. Battle-ship Albion. The Engines of H. M. S. Albion. Combustion in Water-tube Boilers.

JULY 3. Lord Dundonald's Machine Gun. Triple-expansion Marine Engine. Colt's New Machine Gun.

JULY 8. The Evolution of Small Arms. Launch of H. M. S. Amphitrite. The Speed of Warships.

JULY 15. The Largest Storage Battery in the World. The New Graving Dock of the Clyde Navigation Trust. H. M. S. Salamander. The Naval Battle at Santiago. Hydraulic Propeller Starter. H. M. S. Amphitrite.

JULY 22. Aluminum as a Rival of Copper and Brass for Electrical Conductors. Quick-fire Guns for Artillery in the Field.

JULY 29. Lord Charles Beresford on the Russian Naval Programme. Vickers' Quick-fire Field Gun. Propeller Shafts.

AUGUST 5. High-pressure Marine Engines. Trial of Mumford's Water-tube Boilers.

AUGUST 12. The French Naval Defense. Shipbuilding and Marine Engineering on the Thames in the Victorian Era, No. XXI. The Engines of H. M. S. Amphitrite. Manchester Ship Canal. American Gunnery.

AUGUST 19. The Miyabara Water-tube Boiler. Borchardt Automatic Repeating Pistol. The Training of Engineers in Japan.

AUGUST 26. Smoke as a Factor in Naval Action.

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SEPTEMBER 9. Water-tube Boilers and the Manning of Stokholds. Warships in Action.

SEPTEMBER 16. Ships of War in Action. Shipbuilding and Marine Engineering on the Thames in the Victorian Era, No. XXIII.

SEPTEMBER 23. The Austro-Hungarian Torpedo-boat Boa. American Electricity Supply Engines.

SEPTEMBER 30. Shipbuilding and Marine Engineering on the Thames in the Victorian Era, No. XXIV.

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NOVEMBER, 1897. Experiments upon Propeller Ventilating Fans, and upon the Electric Motor driving them. Diagram Accounts for Engineering Work.

JULY. High-speed Self-lubricating Steam Engines.

THE STEAMSHIP.

JULY, 1898. Marine Boiler Explosions. The "Universal" Valve Facing Machine. Burnett's Patent Generator and Water Circulator. The Problem of Combustion in Water-tube Boilers. Transmission of Heat through Plates from Hot Gases to Water. The Value of the Modern Torpedo-boat Destroyer. Launch of H. M. S. Highflyer. The Problem of Combustion in Water-tube Boilers and a Means of its Solution. United States Gunboats. The Trial of H. M. S. Terrible.

AUGUST. Marine Boiler Explosions. Special Service Vessels of the U. S. N. Launch of British Warships.

SEPTEMBER. Electric Lighting on Board Ship. Marine Boiler Explosions. Electrically Controlled Searchlights. The Bretel Boiler Fluid. New Type of Steamer. The Indicator and its Uses on board Ship. The New Battle-ships for the British Navy. Re-boring a Steam Cylinder. The British and French Navies. High-pressure Marine Engines. The Chemistry of Boiler Waters. A Chapter in the History of War Shipbuilding in Great Britain and France. A Ship's Skin.

OCTOBER. The Indicator and its Uses on Board Ship. Shipbuilding in Japan. To Scrape Ships' Bottoms. Speed as an Element of Warship Design. A New Wreck-raising Vessel. Diversity in British Steam Engine Design. Marine Boiler Explosions. The Machinery Equipment of a Modern Battle-ship.

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VOL. XL, 1898. Recent Trials of the Cruiser Diadem. Riveting by Electricity. Investigation of the Nature of Surface Resistance of Water and of Stream-line Motion under certain Experimental Conditions. Horse-power Absorbed by Skin Friction and Wave-making of Different Forms and Proportions deduced from Progressive Trials. Experiments on the Effect of Direction of Rotation in Twin Screws. On Resistance to the Motion of Solids in a Fluid. Reminiscences of Early Marine Steam Engine Construction and Steam Navigation in the United States of America from 1807 to 1850. Description of some Experiments with a Water-tube Boiler. A General Theory of the Oscillations of a Ship on Waves. On Stresses Experienced by a Ship in a Sea Way. The Problem of Stability in Naval Architecture. The Steering Qualities of the Yashima. Submarine Torpedo-boats: their Influence on Torpedo-boat Architecture and Value in Warfare. On the Direct Attachment of Copper Sheathing Plates to the Hull of Vessels.

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MARINE RUNDSCHAU.

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NORSKOI SBORINK.

No. 3, MARCH, 1898. Elements of the Armed Strength of Fleets. The Comparative Strengths of the Fleets of different Powers. Questions in Naval Strategy. Training of the Engineer's Force for the Navy. The Steamer Cherron of the Volunteer Fleet. Corrosion and Fouling of Ships. Additions to "Compensation of the Compass at Night and in Fog."

Notes: Results of Twenty Years' Shipbuilding in Spanish and other Fleets. Trial of the Spanish Torpedo-boat Destroyer Plu-

ton. New Rule for Promotion of Officers in the Japanese Navy. Accidents: Premature Explosion of Powder Charge upon British Gunboat Bouncer.

No. 4, APRIL. Homogeneity in the Composition of the Fleet. The Rôle of Torpedoes in Naval War (translation of Admiral Colomb's pages, "The Future of the Torpedo" in Royal United Service Institution). The French Naval Budget for 1897. Review of Present-day Ordnance. New Method of Manufacture of Armor. Recent and Present-day Types of British Marine Engines. Method of Hull Construction with reduced Supports of Framing. Navigation Notes and Problems: On a Mineral Deposit at the Bottom of the Sea in certain Parts of the Baltic.

Notes: The Spanish Cruiser Rio de le Plata.

No. 5, MAY. Contributions to the History of Military Events in the Far East, 1847-55. The Laws of Development of Naval Strength. Review of Present-day Ordnance (conclusion). Advances in the Construction of Ships' Machinery. Considerations upon the Raising of the Sunken Ironclad Gangout.

Notes: Wreck of the Maine in the Harbor of Havana (translation of official reports). Composition of the Naval and Military Forces of the Powers at War.

No. 6, JUNE. The Question of Privateering. The Comparative Strengths of the Fleets of different Foreign Powers. The Composition of the American Navy in 1897. The Composition and Distribution of Ships' Artillery. Advances in the Construction of Ships' Machinery (conclusion). Practical Problems in the Computation of Sections of Wiring for Electric Installations. Notes on Marine Meteorology.

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Notes: The Spanish-American War. General Position of Affairs. Journal of the War.

No. 8, AUGUST. Navigation and its Influence on the Development of the Russian Empire. The Question of Privateering. The Latest Shipbuilding Programme. German Navy. The Tactical Rôle of Ships' Artillery. Dimensions of different

Parts of Steel Ships. The du Temple Water-tube Boilers. Puddling Steel and its Application to the Production of Cast Steel.

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No. 84. The Examination for Admission to the German Military Academy (a proposition). The Saxon Engineer and Pioneer Corps. The Grand Manœuvres on Salisbury Plain in England. Military News from Sweden. Minor Notes.

No. 85. The Examination for Admission to the German Military Academy (conclusion). Minor Notes.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOL. XXVI, No. 8. The Navy in the Civil War of the United States, 1861-65 (continuation). The American-Spanish War, with Particular Consideration of the Naval Operations. Smokeless Nitroglycerine Powders. The Italian Fleet Manœuvres of 1897. The Naval Budget of Italy for the Fiscal Year 1898-99. Naval Notes: England, France, Germany, Italy, Russia, Holland, Norway, Portugal, United States, Chili and Japan. The English and Russian Fleets in Chinese Waters. The British Merchant Marine. Comparative Table of the Naval Strength of the Principal Sea Powers.

No. 9. The Navy in the Civil War of the United States, 1861-65 (continuation). The American-Spanish War, with Particular Consideration of the Naval Operations (continuation). Smokeless Nitroglycerine Powders (continuation). Session of the Mathematical Natural Science Class of the Vienna Academy of Sciences, June, 1898. The Naval Budget of Holland for 1898. Naval Notes: England, France, Russia, Italy, Spain, Portugal, United States, Argentine, Brazil, Chili, Japan, China, Morocco. The Burning of the Austrian Steamer North Erin. The Coal Production of the World.

No. 10. The Navy in the Civil War of the United States, 1861-65 (conclusion). The American-Spanish War, with Particular Consideration of the Naval Operations. The Austro-Hungarian Polar Expedition under Wayprecht and Royer, and the Nansen North Pole Expedition. Naval Notes: England, France, Germany, Italy, Russia, Portugal, Holland, United States, Argentine, Chili, Japan.

LE YACHT.

JUNE 4, 1898. The Protection of the Colonies.

By a decree of April 3, 1890, the civil governors of the colonies, under the direction of the minister for the colonies, are charged with the duties of the interior and exterior defenses of the distant colonies. Yet, as the writer remarks, in case of a disaster the navy would be held partly responsible for defeat. With Algeria it is different. There the general commanding the Ninth Army Corps, and the admiral commanding at Algiers, are under the authority of their respective ministers in what concerns the military and naval defenses of that dependency, and the writer goes on saying: Would it be unreasonable to ask for the recall of the decree of April 3, 1890, and give to those who would have to protect the colonies in the event of war the opportunity of preparing for their defenses in time of peace?

One thing is certain, and that is that at the present time those defenses are lamentably inadequate; and it could hardly be otherwise, the civil governors being exclusively absorbed by the economical (?) side of their administration. It is therefore upon the military commanders in the colonies that should devolve the duty and the right to directly inform in advance their respective authorized heads of the necessary preparations in regard to the land and sea defenses, supplies of all kinds, provisions and war materials, as well as to the personnel.

The land defenses should consist, as at home, of concrete works with armored shelters to withstand modern guns, as well as ground torpedoes, and blockade torpedoes, if advisable. Against such fortifications even armored battle-ships with their high-power guns would be powerless, exposed to serious injury, and would uselessly spend their ammunition, depleting their magazines, perhaps on the eve of a naval battle, as in the case of Sampson at San Juan of Porto Rico, with a negative moral effect.

It would be folly to depend upon fortifications of the kind Admiral Dewey reduced so easily at Cavite; better have none at all, thus depriving the enemy of the boast of an easy triumph. A simple mortar battery hidden from the sea and invulnerable would make the anchoring of a hostile fleet in roads like Manila Bay untenable.

Let us now examine the mobile defenses. In case of a conflict with a maritime nation some of our colonies would be subjected to a blockade, and as they are not self-supporting in the way of subsistence, the blockade would result in a famine, and finally in surrender. This is the danger that actually threatens the dependencies wrested from Spain, and what they need is a flotilla of small coast-defense torpedo-boats, or perhaps simple vedettes. This is the first requisite element of mobile defenses.

The Protected Cruiser d'Entrecasteaux of 8114 Tons Displacement.

Length, 117 metres; extreme breadth, 7.15 metres; maximum power, 13,500; contract speed, 19 knots. The armament includes two 24-cm. guns in closed turrets, twelve 14-cm., eight of which are in armored barbettes and four on the spardeck; twelve 47-mm. and four 37-mm. placed on the bridges, besides six torpedo tubes, two of which are below the water-line. The military masts in the original contract have

been replaced by signal masts. The steam apparatus arrangements have also been modified to admit of compound firing. To that effect, an oil tank with a capacity of 40,000 litres has been built in the hold. The burners will be fed by Thirion pumps from special reservoirs. The electric installation comprises all the necessary organs for working the turrets, for the interior and exterior lights of all kinds, for transmitters of orders, ventilators, ash hoists, and hoists for ammunitions of all calibres. These are divided in two groups, one forward and one aft. The forward group, placed in the forward 240-mm. turret, comprises two engines, and the one in the after turret four. The incandescent lighting in the interior comprises 410 lamps of 10 candle-power each, and on the exterior 56 lamps, with an intensity averaging between 10 and 50 candles. There are six Maugin searchlights fitted with a distant electric command. The electric ventilators are of the Rateau, Sautier and Harlé system. Originally the six ash hoists were to be worked by steam, but are now worked by electricity or by hand. The electric ammunition hoists are three in number for the 37-mm. and 47-mm. projectiles, ten for the guns of 138.6 mm. and two for the guns of 240. All the command apparatus of these hoists are of the Savatier, Lagabbe, Sautter-Harlé system. Each turret is provided with an electric pump intended to remedy the leaks of the pivot-press. The pumps work automatically. The working system of the 240-mm. turrets is similar to that of the "tourelle battante"; the type of motors is Sautter and Harlé.

Everything has been done to make the habitability of the cruiser as complete as possible for officers and men serving in tropical seas.

Right aft, on the between decks, are the admiral's quarters, with salon, dining-room, pantry, bathroom, etc.; also the messroom of superior officers, officers' staterooms and other necessary rooms, and forward are the "corneaux" of the crew. All the partitions are of light-nerved sheet-iron, with the exception of the admiral's apartments' partitions, which are perfectly smooth to allow of decorations. The various articles of furniture, bedsteads, bureaux, desks, etc., are all metallic. The various magazines, provision-rooms, spirit-rooms, ammunition-rooms, coal-bunkers, etc., are all placed under the protective deck.

JUNE 11. The Rights of Neutrals and International Rights.

JUNE 18. Specialization of Cruisers: Express Cruiser (Croiseur estafette).

The estafette is intended to establish and maintain communication between armored cruisers detached from a squadron or a navy-yard for the purpose of discovering and following the enemy, and that squadron, or navy-yard, or whatever base of operations. It should also keep open communications between the metropolis and the near colonies in spite of a blockade, or the presence of a hostile fleet between France, Algiers and Tunis. Owing to the nature and importance of its rôle the estafette should be able to avoid any venture that might jeopardize its mission. That condition fixes its minimum speed, which can never be inferior to 23 knots.

Grounding and Floating of the Victorious.

No. 1059, JUNE 28. The Landing of Troops. Launching of the Brazilian Armored Cruiser *Marechal Deodoro* of 3162 tons.

No. 1060, JULY 2. Specialization of Cruisers: Commerce Destroyers (V. G.).

No. 1061, JULY 9. The Destruction of the Spanish Squadron off Santiago.

No. 1062, JULY 16. After the Naval Fight off Santiago (E. D.). The Cruiser Protet, built by the Forges et Chantiers de la Gironde.

No. 1063, JULY 23. Reorganization of the School of Higher Studies. The Mobile Defense of Bizerta.

No. 1064, JULY 30. The New Building Programme in England.

No. 1065, AUGUST 6. The Double-acting Manœuvres in the Mediterranean (E. Duboc).

No. 1066, AUGUST 13. The Combined Manœuvres of the North Squadron.

No. 1067, AUGUST 20. The Russian War Fleet.

No. 1068, AUGUST 27. American Official Report of the Naval Battle of Santiago.

No. 1069, SEPTEMBER 3. The English Armored Cruisers. The Protected Cruiser d'Assas.

No. 1070, SEPTEMBER 10. The New Naval Construction Programme in the United States.

No. 1071, SEPTEMBER 17. Living Conditions on Board Modern Men-of-war (continuation).

No. 1072, SEPTEMBER 24. The Merchant Navy and Ship-yards.

After deploring the gradual and constant decline of the French merchant navy whilst those of her neighbors have increased—England's, 53 per cent.; Germany's, 107 per cent.; Spain's, 30 per cent.; Italy's, 57 per cent.—the writer points out a remedy. Create the commercial navy construction industry and reorganize the maritime credit are the two conditions *sine qua non* of the revival of the merchant navy, without which no nation can have an export trade, a prosperous industry or flourishing colonies, or foreign influence, and history points out that peoples that have devoted themselves to maritime commerce have become the masters of the world.

The Armored Battle-ship Bouvet of 12,200 tons. J. L.

REVUE MARITIME.

MAY, 1898. A Guide-book for Naval Officers and Sailors Travelling over French Railways. Lithologic Analysis of Marine Deposits taken from the Bay of Biscay. The National Hour.

Geographers, astronomers and seafaring people heard with undisguised surprise that the French Chamber voted without discussion a law making

the Paris meridian less 9 minutes 25 seconds the national hour for France. This, it will be noticed, corresponds with the Greenwich time. This same bill had previously been voted down, being strenuously opposed by the ministers of war, marine and public instruction respectively, as likely to involve regrettable consequences. On the other hand, the adoption of the Greenwich meridian had been rejected in December, 1896, by the Geographical Society; and the Astronomical Society adopted a similar resolution at about the same time. It is hinted that the change is due to the railway and telegraph companies; but these companies will derive very little benefit from the change compared with the great inconvenience that will result to the general public.

Foreign Navies.

JUNE. The French Oceanographers (continuation).

See *Revue Maritime* of March, 1897, p. 443, and of Sept., 1897, p. 542.

Foreign Navies. Coast Defenses, translated from the Italian. The Fighting Ships of the Future.

An interesting study of modern ships published in the *Marine Rundschau* of July, 1897, and reproduced at length in the *Revue*.

JULY. Gymnastics of the Sailor. Free use of the Flag in Naval Warfare. The Necessity for a Reform. J. L.

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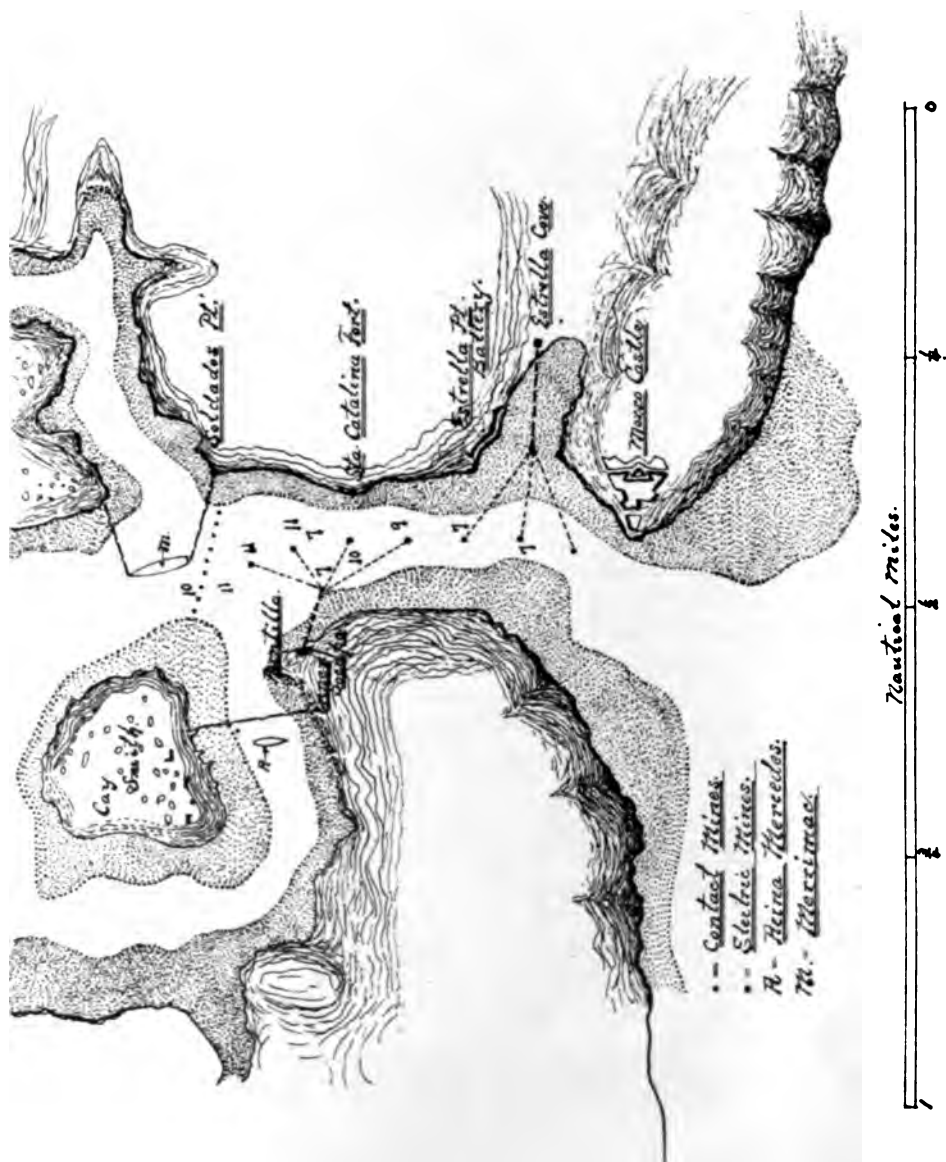
NAVAL INSTITUTE.

VOLUME XXIV.



EDITED BY GEO. F. COOPER.

PUBLISHED QUARTERLY BY THE INSTITUTE.



SITUATION AFTER SINKING OF MERRIMAC.

cept for a small slit about four inches deep, and just long enough to take in the two ends of the mine field to be operated. These stations contained the most elaborate electrical appliances for testing the circuits and for firing. A large table with testing battery, Wheatstone bridge, and galvanometer was found in each, together with a firing battery, sighting quadrant, and numerous books giving full descriptions of the ships of our Navy, with photographs accompanying. All stations were in telephonic communication with each other. After the surrender it was discovered that on account of the failure of the three mines controlled by the Estrella Cove station, that station was abandoned. Only parts of the testing and firing mechanism were found there, other parts having been destroyed or carried off. The stations on Cay Smith, and Outer Socapa were also abandoned, as the inside station on the Socapa side was considered to be so advantageously located that it, alone, was considered sufficient to control the remaining mines.

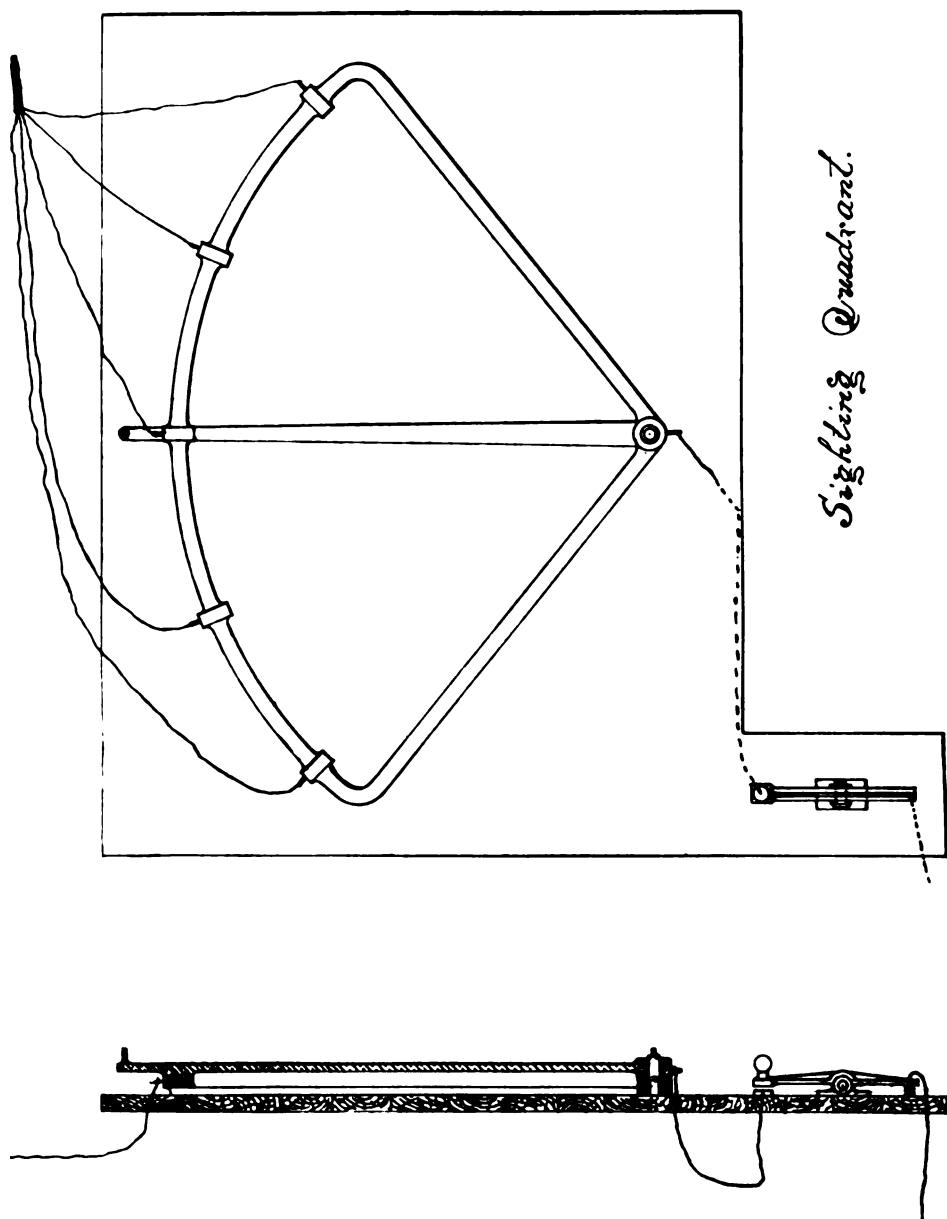
SIGHTING QUADRANT.

The means of determining the proper moment to fire the electrical mines were a sighting bar in connection with a quadrant of a circle, having on it as many contact points as there were mines in the mine field. The sighting bar was pivoted at the center of the circle from which the arc was described, and could be swung around so that its front end could be brought in contact with any one of the contact points on the arc.

The whole arrangement was evidently installed in the control station, and the mines planted on the ranges indicated by the line of sight as given by the bar in its various positions, that is, with its front end on the different contact points of the arc.

The main cable was made up of a number of small well-insulated cables, all bound together and covered with jute braiding for the distance from the control station out to the junction box, and where this cable came into the control station it was made fast, and the separate parts of it were each led to one of the contact points on the arc of the sighting quadrant. These wires, and the contact points were numbered with the same numbers that had been assigned to the mines as they were planted.

Outside of the control station the cable ran out into the water for about one hundred and fifty yards where it led into a junction



box, from which branch leads radiated to each of the mines planted. The mine connection of each of these branches was as follows: In the top of the mine was a water-tight stuffing-box, through which the leading wire entered and made fast to one pole of the detonator, the other pole being made fast to the metal of the stuffing-box outside the mine. At the shore end of the cable one pole of the firing battery was placed in contact with the earth, and the other connected to the sighting-bar, the firing-key making a break between the two.

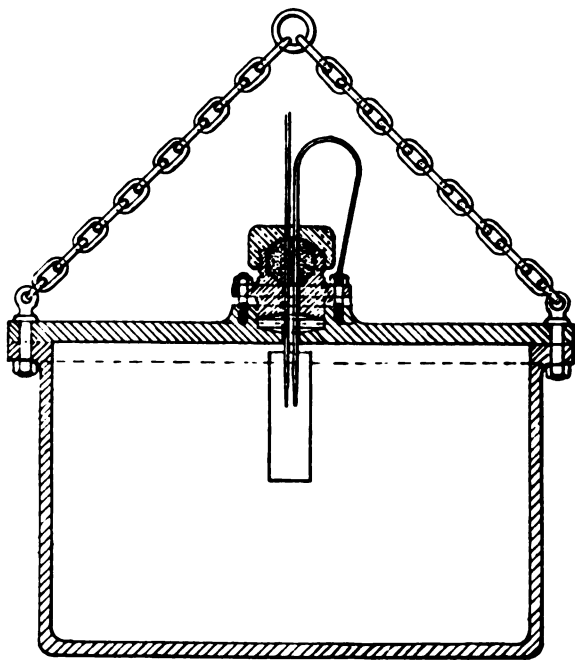
To test any particular mine, place the front end of the sighting-bar on the contact point of the arc corresponding to that mine and, with the testing key and testing battery, in connection with the Wheatstone bridge, and galvanometer, the good or bad qualities of the circuit were established. The arrangement was very simple and at the same time very complete.

To fire a mine under a vessel attempting to run the channel, connect with the firing battery, take the guard off the firing key, and, when the vessel comes on your line of sight, as indicated by the front and rear sights of the bar, press the key.

In order to make the entrance of the harbor safe for the passage of our ships the commander-in-chief, on July 17th, sent a working party in to destroy the electrical mines, and raise the contact mines. Of the four presumably good electrical mines off Inner Socapa, two failed to show continuity of circuit, and, after repeated attempts to detect their faults and to fire them, their positions were located and they were noted "to be raised." The other two were successfully fired, but the column of water thrown up by each was surprisingly small. This may be accounted for, in part, by the great depth in which they were planted.

The two noted "to be raised" were recovered in the following manner without any accident whatever: The "Suwanee," under the command of Lieutenant-Commander Delehanty, was sent in to assist in recovering these mines, as she was fitted with just the sort of anchor gear that was necessary to use in lifting them, and after the chain sling of the mine was once secured, she simply hooked her fist fall in the ring in the end of it, and with her steam winch hoisted the mine up clear of the water. All connections at the control station were broken, simply as a matter of ordinary precaution; the main cable was underrun by a dinghy for about one hundred and fifty yards, where a junction box was found. By

means of a wrench the nuts holding the top on it were taken off, and the box was found to contain a branch lead from the main for each mine planted, each lead having a tag on it corresponding to its number on the contact point on the sighting quadrant. Knowing the numbers of the two mines fired, it was an easy matter to take each of the other two in turn and, leaving the junction box in a boat, underrun its cable until the end of a small chain was



Observation Mine.

found stopped to it at intervals. This chain had a ring in its end, and, after casting it adrift from the cable, the boat was hauled over until it led up and down. The "Suwanee" then steamed up and hooked her fish fall in the ring in the end of the chain, hove the mine up above the water, and a steam launch went alongside and received it. A short chain sling led from each corner of the mine to a ring in the center, and to this ring the hoisting chain made fast. A vessel like the "Suwanee," or a large launch

or tug with good tackles, is absolutely necessary in raising these mines, as they weigh close on to a ton and, if the bottom is soft, sink into the mud for a considerable distance.

The mines recovered were of the following general description: The case was of cast iron, about three-quarters of an inch thick, the top and body being cast separately, and, after the charge of gun-cotton had been placed inside, these were securely bolted together, with a rubber washer between them. The whole thing was in the form of an iron box about thirty-six inches on a side, and about twenty inches deep, and, as stated before, the leading wire entered through a central water-tight stuffing-box. The detonating agents were two fulminate of mercury detonators, each containing about seventy grains, as well as could be judged, connected in parallel, and embedded in the heart of the dry gun-cotton primer.

To prevent injury to the connections, from pulls or sudden jerks on the leading wire, a cuckold's neck was turned in it, and made fast to a ring on one of the corners of the mine. As soon as the mine was in the launch the stuffing-box was taken off to permit of an examination being made, and this should always be done if recovering a mine that has failed to fire. If the detonators have fired, well and good, if not, then remove them from the mine at once as a matter of precaution.

The remaining mine off Inner Socapa and those off the *Estrella* station were recovered in the same general way by the "*Suwanee*."

CONTACT MINES.

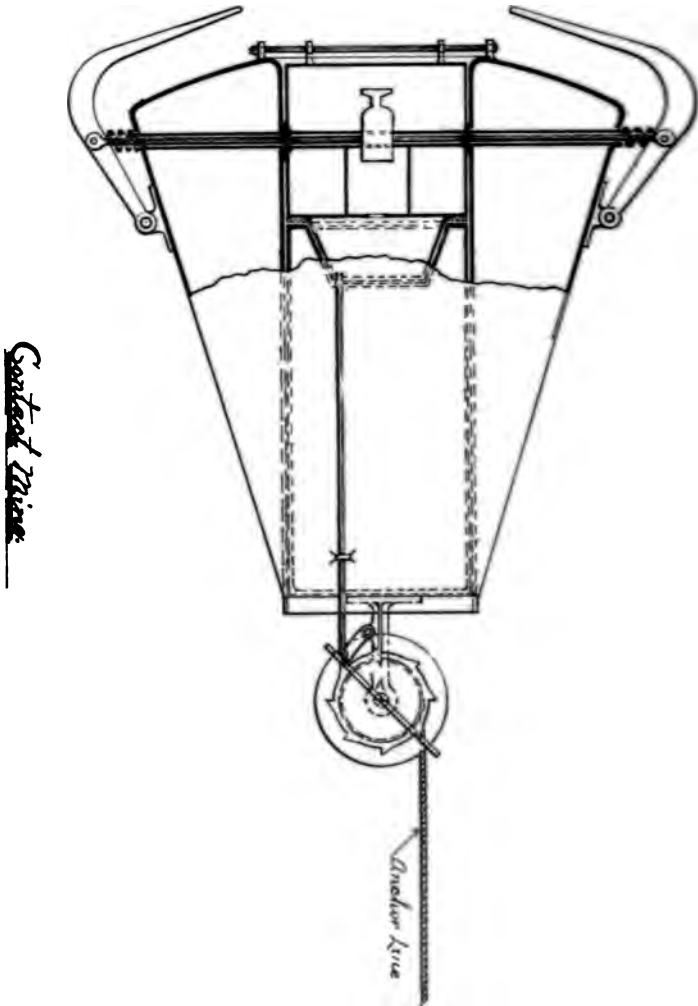
The line of contact mines, running from Cay Smith across to the eastern bank, passed just under the stern of the *Merrimac* and completely blocked the channel, but on the afternoon of July the second four of these mines were taken up between Cay Smith and the *Merrimac*, and, on the morning of July third the connections at Inner Socapa were temporarily broken so that the Spanish fleet passed out in perfect safety. After they had passed the mine fields the connections were immediately made again, and the four contact mines planted in their original places. (Chart.)

The operation of recovering these contact mines will probably be better understood after a brief explanation of the method of planting them, and a description of the different parts has been given. The description, as here given, is of the mine as it was



CONTACT MINES AND CABLE REELS.

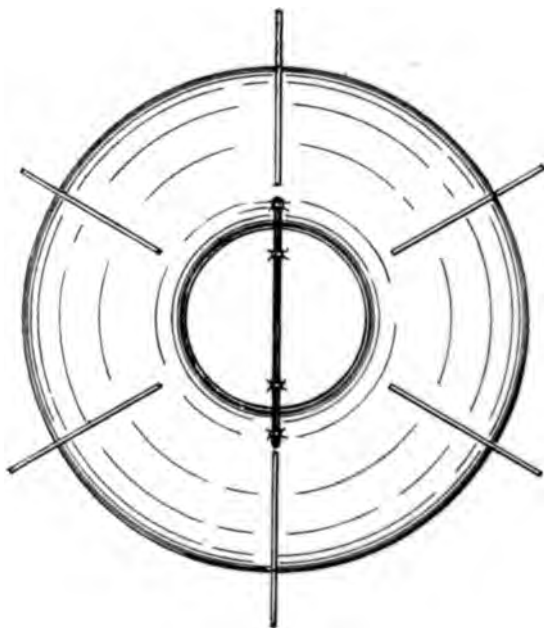
found at Santiago, and may not be exactly technically correct according to the ideas of the inventor, but is correct regarding those recovered. The mine is in the shape of a conical buoy thirty-two inches in diameter at the top, and twelve and one-half



at the bottom, and stands thirty-six inches high. It has a central axial hole in it eleven and three-quarter inches in diameter for the entrance of a cylinder containing the charge of wet gun-

cotton. The bottom of this hole is closed by an iron plate, and on the outside of this plate is secured the frame of a reel which carries about twenty fathoms of wire rope for anchoring the mine. On the barrel of the reel is a toothed wheel, against which a pawl is held by a spring, preventing rotation until the pawl is raised.

On each end of the barrel, outside the frame, is a two-bladed fan, the area of each blade being about sixty square inches. When the pawl is lifted, by a rod running up alongside the mine,



PLAN OF TOP OF CONTACT MINE.

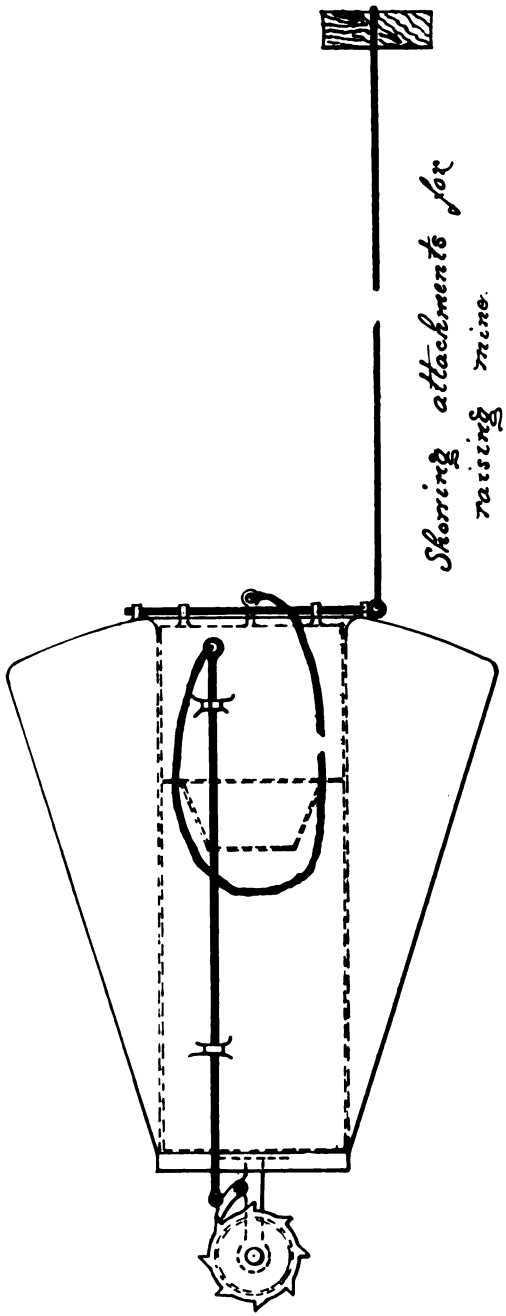
it releases the reel and allows the wire to unwind, and by letting go this rod the spring holds the pawl hard against the toothed wheel and stops the revolution of the reel. The fans are to prevent a too rapid revolution of the reel and a consequent snarling of the anchor wire.

The cylinder which fits in the central hole in the mine contains forty-five kilos. of gun-cotton, and is secured to the bottom plate by four bolts and nuts, but does not reach to the top of the mine by about eight inches.

In the upper end of the cylinder is a conical hole for the reception of a vessel containing the dry primer of gun-cotton. This vessel containing the dry primer is secured against a rubber washer, on the bottom of a small hollow cylindrical buoy, which fits in the upper end of the same axial hole as the large cylinder containing the wet charge.

Inside of the small hollow cylinder are six plungers, spaced at equal distances around the circumference, and converging to the center, where their inner ends rest on a glass tube filled with sulphuric acid; their outer ends being in contact with plungers operated by contact arms on the outside of the mine. The hole in the small buoy where the outer ends of the plungers make contact with those operated by the contact arms is covered with thin sheet lead to make the buoy water-tight, the blow from the contact arm being sufficient to rupture this lead when the mine is struck by a passing vessel.

Around the tube of sulphuric acid is a composition of chlorate of potash and sugar, and a central hole gives communication between this composition and the dry gun-cotton in the conical vessel attached. To the eye, the only substances that could be absolutely determined were the chlorate of potash and the sugar, but this alone will not make, with sulphuric acid, a detonator. Therefore, there must have been some fulminate in combination with these two substances, or in the heart of the dry primer of gun-cotton, to produce a detonating effect. I quote from an opinion of the chemist at the U. S. Torpedo Station, Professor H. F. Brown. "The reaction of sulphuric acid, potassium chlorate and sugar will evolve a large amount of heat and will probably result in an explosion. This explosion will ignite dry gun-cotton, which, consequently, will produce an explosive effect. It is my opinion that this explosion will not be a true detonation unless there intervenes some fulminate of mercury, or other substance whose ignition, like that of the fulminate, amounts practically to a detonation. I should not expect the explosion of a mass of wet gun-cotton which might be adjacent to the dry primer (of gun-cotton)." This opinion is fully substantiated by other authorities, and therefore, although no fulminate appeared to the eye of the observer, it must have been there, or the mine would have been valueless. The detonating agent is, therefore, the material in the buoy and the dry gun-cotton primer.



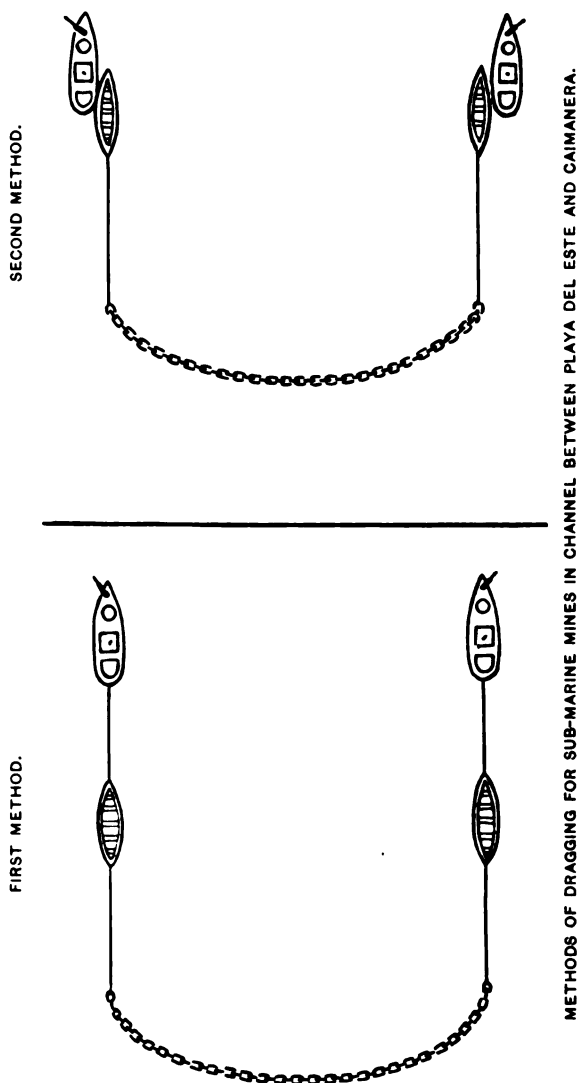
In planting the mines the buoy and dry primer attached are placed in position in the upper end, as a last preparation, and a small rod is run across the top of the mine through lugs, to hold it in place. To one end of this rod a line is made fast, and to the end of the line a small wooden buoy is secured, intended to act as a signal buoy, the length of the line being so judged that the buoy will float a short distance under the water when the mine is planted. The buoy carrying the dry primer has a ring in its top to which a line, from the upper end of the rod operating the pawl on the reel for the anchor wire, is made fast.

The depth of water is known, as is also the depth below the surface it is intended the mine shall float. Having the mine slung, pull up on the rod operating the pawl on the reel and allow the wire to run out to the depth of water, minus the depth below the surface the mine is to float; let go the rod and lower away gently on all. The mine is pulled down under the water and floats at the depth determined upon, while the small wooden buoy, acting as a locating buoy, floats about one foot under the surface. (Sketch.)

The location of the line of contact mines was known, approximately, before the surrender, and this knowledge was verified by the commanding officer of the Spanish gunboat "Alvarado" captured in the harbor. A small boat was used in raising the mines, and the work was carried on in the early morning on account of the light and smoothness of the water, which became rough later on in the forenoon and made it difficult to locate the signal buoys. Once on the range the boat was pulled slowly, with a number of watchers on each side. As soon as one of the small wooden buoys was sighted it was secured, and by pulling on the line steadily the pin running across the top of the mine, holding the cylindrical buoy, with dry primer attached, came out, allowing the latter to rise to the surface quickly. Attached to the ring in the top of the cylindrical buoy is a line which has its lower end made fast to the rod operating the pawl on the reel for the anchor wire. Pull up on this line, lift the pawl, and allow the wire to unreel until the mine comes to the surface.

Lift the cylindrical buoy, with dry primer attached, in the boat, and you have nothing to deal with in the mine but a charge of forty-five kilos. of wet gun-cotton. By pulling up on the rod operating the pawl of the reel, and reaching down with a boat

hook, the bight of the anchor wire was secured and the anchor weighed. A line was then made fast to the mine and it was



METHODS OF DRAGGING FOR SUB-MARINE MINES IN CHANNEL BETWEEN PLAYA DEL ESTE AND CAIMANERA.

towed ashore and hauled up on the beach. The work of recovering eight of these mines required less than a day. This method of recovering contact mines presumes, in the beginning that their

location is fairly well known, as, otherwise, the plan of sweeping for them with two boats must be carried out, as was done by the Marblehead and Dolphin at Guantanamo.

The work of sweeping for the mines at Guantanamo was done at a time when those engaged in it were likely to be subjected to the fire of Spanish riflemen in pits on the left bank of the channel leading up to Caimanera. These pits were covered by the guns of the two ships whose boats were engaged, whilst the pulling boats, in tow of the steam launches, also contained riflemen. The general plan was to sweep with the chain, and line between the boats as indicated in the sketch, and when a mine was secured, place wedges between the body of the mine and the contact arms, as a precautionary measure, until the dry primer could be taken out.

Before leaving the subject of contact mines I wish to say that I discovered an appendage to some of those recovered which I was at loss to understand. This was a small cylindrical bouy, about five inches high, and about eighteen inches in diameter, and was attached by a line to the rod operating the pawl of the reel for the anchor wire. It apparently had been intended to act as a buoy in the original design, but, as found at Santiago, there were holes punched in its sides, as though by a nail, and the result was that instead of acting as a buoy, it had an appreciable weight to it and pulled down on the rod to which it was attached, thus assisting the spring to hold the pawl on the toothed wheel. On some of the mines this was missing, and its office on those where it was found seemed to be of very little importance.

During the latter part of June a plan for countermining the channel leading into Santiago was developed and approved by the commander-in-chief; the officers who had volunteered to carry out the scheme reporting everything ready on the first of July.

The destruction of the fleet, the surrender of the Span my, and other incidents made it unnecessary to carry out the p developed, but it is simply noted here that the plan was : the accepted ideas of all nations, that is, to explode : ously, a number of heavy mines, containing about five h pounds of gun-cotton in the mine field. These mi have been dropped in succession from a boat, to d

launch or steamer, and the whole exploded as the last mine reached the bottom. The explosion of a countermine of five hundred pounds of gun-cotton will destroy all mines within a radius of from two to three hundred feet, and the practical application of the proposed plan had every chance of success.

The mine fields were well protected by many rapid-fire and machine guns secreted on the Socapa side of the entrance; the guns and carriages being painted the same color as the earth, and almost entirely covered with brush. Between Puntilla and Cay Smith the Reina Mercedes lay in the cove, protecting the line of contact mines, whilst Punta Gorda battery could fire straight down the harbor. Added to this, the brush on each side of the entrance was thick with concealed riflemen.

Nature had done everything to assist in the protection of the channel, the electrical mines were of the most approved type, and the contact mines, if properly attended to, were dangerous to an enemy. But the very best of tools, if placed in the hands of inexperienced or indifferent workmen, will seldom give good results.

The mines in the entrance were said to have been planted by the officers of Admiral Cervera's fleet, and there were many evidences of the hurry with which they were put down. Lieutenant-Commander Delehanty, who commanded the "Suwanee," and who lifted the observation mines with his ship, says: "None of the mines were recovered intact. The connections were, as a rule, broken, the dry primers drowned out, or the mines partially exploded."

In many places the coverings of the branch cables were chafed off, and some of the strands of the wire bare; the result, no doubt, of paying the cable over the gunwale of the boat used in planting the mines.

The maxim, "that insulation is for the purpose of making electricity go where we want it to go," had evidently never occurred to the officers engaged.

In one electrical mine recovered, there was evidence of a partial explosion, which did not show at the surface of the water. The bottom of the mine was partially blown away, leaving about one-half of it intact, and inside the mine was a large quantity of wet gun-cotton, which rolled out of the hole in the bottom as the mine was lifted and lowered into the launch alongside of the "Suwanee."

In firing exercise spar torpedoes at the torpedo station, the writer has seen it frequently happen that a leak in the top of the case would admit enough water to prevent a detonation, but the case would be ruptured and the torpedo, on recovery, would show that the detonator had gone off, but that the dry primer had become damp or wet. A careful examination of the mines recovered seems to indicate that one of the small, and almost insignificant points connected with the preparation of mines had been entirely ignored. I refer to the method of securing the stuffing-box to the top of the mine. The fact that so many mines had the dry primers drowned out, together with appearance of the stuffing-box, proved that, instead of screwing down gradually on the nuts, securing the stuffing-box to the mine, so that the flange would take equally all around, one side was screwed down tight, and then an attempt was made to screw down the other side. Experience proves that this is not always possible, and I believe that this accounts in a great measure for the failure of most of the mines.

Another point was that the mines seemed to be placed too close to each other. Taking the length of channel to be guarded, and considering the fact that five hundred pound mines may be destroyed, if within three hundred feet of each other, it appears that these were too close, and the detonation of any one of them would, if it did not detonate the others next to it, at least, destroy their electrical connections and render them absolutely useless. This did happen at Estrella, and I believe also at Inner Socapa. The mines that were fired at the Merrimac utterly destroyed the connections of the three that were left at Estrella.

To get the full effect of a mine a ship must naturally be over it, but this can seldom be brought about unless two control stations are occupied. After the Merrimac sank, all but one of the stations at Santiago were abandoned, and therefore it would have been a stroke of extremely good fortune had a mine been detonated at the exact moment when a ship was over it. Experiments have, however, been made to determine the horizontal distance at which an armored vessel would be vitally injured by different charges of gun-cotton in mines, the following being the results:

Mine.	Submergence.	Dist. horizontally.
150 lbs.	10 to 15 feet.	4 feet.
250 lbs.	30 feet.	10 feet.
500 lbs.	60 feet.	15 feet.

This last corresponds nearly with the conditions existing at Santiago, but with the faults in the circuits, and the other attending difficulties, it is scarcely likely that these figures would have been reached.

CONCLUSION.

Contact mines of the type encountered at Santiago and Caimanera are liable, from the growth of barnacles, to become very much impaired as regards the operation of their different parts, especially the contact arms. This growth forms so rapidly in the warm water of the tropics that in a very short space of time it is sufficient to prevent the arms from driving the plungers in far enough to break the vial containing the sulphuric acid. They therefore require constant attention, and from observation it seems that, to make them effective, they should be raised and cleaned about once in three weeks. The examples of the Texas and Marblehead picking up on their screws mines of this description, are sufficient to illustrate the harmless condition to which they may revert, no matter how good they may be when planted.

Had due care been exercised in planting the electrical mines, and a fair amount of attention paid to the contact mines in Santiago harbor, no ship could have passed the two fields. But the well-known character of the people who planted and attempted to operate them accounts, in a great measure, for the condition in which they were found.

The moral effect of a mined harbor is tremendous, and the question of risking valuable ships is of vital importance. What would have happened to a ship attempting to run the mine field is problematical, but the chances were that she would have been sunk, for, notwithstanding the number of bad mines encountered, enough good ones were left to destroy her.

The electrical mine was perfect in type and design, and had it been properly planted and cared for the protection given by it to the entrance would have been absolute.

The lesson to be learned is evident:—mines cannot be planted hurriedly and carelessly, allowed to remain without attention, and then be expected to give theoretical results.

Officers of Admiral Cervera's fleet stood watch in the control stations at Santiago, and must, naturally, have been alert and attentive to their duties, so that in considering the matter from

all sides the facts which come home to us are these: The theoretical knowledge of those who selected the firing stations, planted the mines, and weighed the question of properly defending the channel was fairly perfect, but in the vital point of a *practical* knowledge of how to prepare and plant these mines they were deficient.

It does not require much of an argument to convince us all that practical education in this particular branch of our profession is what the service needs. The *details*, at times so seemingly insignificant and unimportant, are just the trifles which make success or dismal failure. In a mine defense one cannot admit, for an instant, that there is a chance of failure, for it must be so perfectly installed that it may be counted upon with perfect confidence. This is feasible and possible, and a course of training would, in a short time, make the members of our service masters of the important details, without which knowledge no assured success can be expected in either mine defense or countermining.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PYRO-COLLODION SMOKELESS POWDER.—PART II.

By PROFESSOR D. MENDELÉEF.

(Translated from the Russian by Lieutenant JOHN B. BERNADOU, U. S. N.)

The "combustion" of a powder is the union of the carbon and hydrogen of the mixture or compound with the oxygen that it contains, and with which it is in association, but not in direct combination. From what has been said already, it is evident that if the powder is to be smokeless and produce the maximum volume of gas, V_{1000} , it must evolve no other gases than carbonic oxide, CO, water vapor, H_2O , and nitrogen, N_2 . If hydrogen be evolved, without the formation of the corresponding quantity (equal volume) of carbonic acid, free carbon may result; *i. e.*, the powder will not be wholly smokeless on account of insufficiency of oxygen. If the combustion, as indicated by the equation, reveals carbonic acid or free oxygen (without the corresponding volume of hydrogen), an excess of oxygen is evident, and V_{1000} will not possess its maximum value.

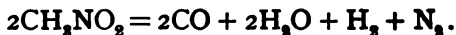
We have, therefore, in the case of a composition or mixture $C_nH_{2m}N_qO_r$, the maximum volume V_{1000} for typical smokeless combustion, corresponding to two conditions: (1) When the content of oxygen, r , is just sufficient to convert the carbon into CO, and the hydrogen into H_2O , *i. e.*, when $r = n + m$; (2) when the content of hydrogen is relatively great, as V_{1000} for H_2O equals 111.1, *i. e.* more than for nitrogen and for carbonic oxide, for which $V_{1000} = \frac{2000}{26} = 71.4$. Moreover, all substances of the composition $C_nH_{2m}N_qO_{n+m}$ will develop volumes between 71.4 and 111.1, if the decomposition products be CO, N_2 , and H_2O alone, as is required for rendering V_{1000} a maximum. Our problem becomes, therefore, the comparative examination of those

bodies rich in hydrogen, for which V_{1000} may be greater than for pyro-cellulose (81.5). We must ask: Are there not known substances, or mixtures of substances, rich in hydrogen suitable for smokeless powder? To answer this query, let us examine various definite compounds and mixtures.

Among the carbon compounds a large content of hydrogen is characteristic of methane (marsh gas) CH_4 ; among the nitrogen compounds, of the ammonium derivatives.

Hydrocarbons of the limiting (saturated) series $\text{C}_n\text{H}_{2n+2}$ * form nitro-compounds, and may, therefore, produce explosives. To methane itself, CH_4 , correspond mono-nitro-methane, $\text{CH}_3(\text{NO}_2)$; di-nitro-methane, $\text{CH}_2(\text{NO}_2)_2$; tri-nitro-methane or nitro-form $\text{CH}(\text{NO}_2)_3$, and tetra-nitro-methane $\text{C}(\text{NO}_2)_4$. These substances are volatile as well as explosive, but all represent a deficiency or an excess of oxygen. As shown by V. Meyer and Professor Zalinski, the explosive properties of mono-nitro-methane are especially great when it is combined with potassium or sodium to form the metallic salts, CH_3KNO_2 , CH_3NaNO_2 , which represent, so to speak, first homologues of the salts of nitric acid, since $\text{CH}_3\text{NaNO}_2 - \text{NaNO}_2$ equals the homologous difference CH_3 . Experiment shows that this substance belongs to the category of detonating explosives, and is, therefore, unsuitable for use in guns (but suitable for mines).

If the decomposition proceeds without formation of free carbon (although there be but little oxygen) it should be as follows:

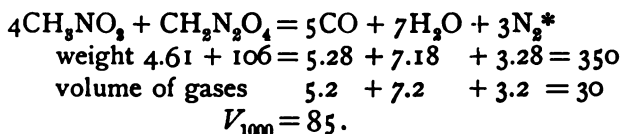


If it be thus, then $V_{1000} = 98.3$, which is very great. But, as has been said, the substance is unfit for use in guns on account of its tendency to detonate. Besides, like other nitro-methanes, it is volatile, and for this reason is further unadapted.

The little known, but doubtlessly explosive di-nitro-methane contains an evident excess of oxygen, developing on combustion, $\text{CO}_2 + \text{H}_2\text{O} + \frac{1}{2}\text{O}_2 + \text{N}_2$, which corresponds to the relatively small volume $V_{1000} = 66$. It is evident that the excess of nitrogen and of oxygen combined with it in the NO_2 , according to the known principle, does not increase but rather diminishes V_{1000} .

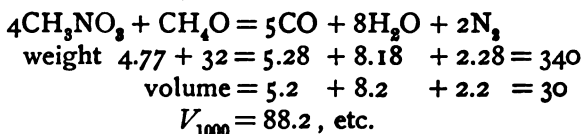
* See "The Principles of Chemistry," by D. Mendeléef, Ed. 1891, Longmans, Green & Co., London, Vol. I, p. 344. J. B. B.

The same is true for nitroform, $\text{CH}(\text{NO}_2)_3 = \text{CHN}_3\text{O}_6$,† and for tetra-nitro-methane, whose discovery is due to the skill of our eminent savant, L. N. Shishkov, both of which contain too much oxygen to develop maximum gas volume. A large value of V_{1000} would be characteristic of mixtures of products of nitration and of hydration (substituting the water radical for hydrogen, $-\text{H} + \text{OH}$) derived from methane, as



or

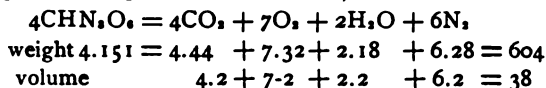
Nitro-methane. Methyl alcohol.



But such mixtures, although possible from the chemical standpoint, are unsuitable for use as powder, as their constituents are in part volatile; and this, apart from the consideration that liquid explosives are liable to detonation, which is more to be dreaded than formation of smoke, as detonation destroys the guns.

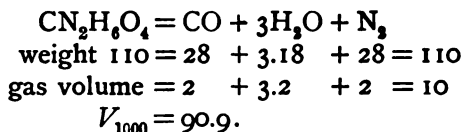
Among the closely allied derivatives of methane as a hydrocarbon rich in hydrogen, the development of a large gas volume may be looked for from substances presenting the composition $\text{CN}_2\text{H}_6\text{O}_4$. Such a composition is possessed, for example, by the mixture of a molecule of formic aldehyde (or of one of its numerous polymers) CH_2O , with ammonium nitrate, NH_4NO_3 , or the hydroxyl derivative of methylamine (*i. e.* CH_3NH_2 in the form $\text{CH}_2(\text{OH})\text{NH}_2$) in combination with nitric acid, HNO_3 .

† As the typical decomposition of nitroform, we have—



* The mixture $7\text{CH}_4 + 3\text{C}(\text{NO}_2)_4$ presents such a composition, etc., but they are all as practically unsuitable for powder as mixtures of mono- and di-nitro methane.

The typical decomposition of such a compound, if realized, would be expressed by the equation:



But such a compound either cannot be produced, or else is attained only with great difficulty; or, as a mixture of ammonium nitrate with the polymers of formic aldehyde (*e. g.* glucose, $\text{C}_6\text{H}_{12}\text{O}_6 = 6\text{CH}_2\text{O}$) develops undesirable qualities, such as hygroscopicity, a characteristic of all mixtures containing ammonium nitrate, and is therefore unsuited for use as smokeless powder.

Hence, after searching through all the possible combinations of the simplest derivatives of methane, we are unable to find among them (as also among substances containing no carbon) any suitable for employment in practice as smokeless powder, although we find compounds developing larger volumes of gas than pyrocollodion, which may prove suitable for use in mines.

If we turn from substances containing one atom of carbon to those with two, three, etc., atoms to the molecule, we shall find, other conditions being the same, smaller values of V_{1000} , the volume decreasing the farther the limit is departed from, as is illustrated in the following table of possible, little volatile, compound ethers of nitric acid* and their hypothetical nitro-compounds, corresponding to the series of alcohols, $\text{C}_n\text{H}_{2n}(\text{NO}_3)_2$.

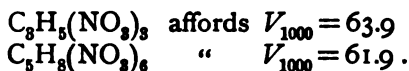
$3\text{C}_2\text{H}_4(\text{NO}_3)_2 + 2\text{C}_3\text{H}_6\text{O}_3$	$V_{1000} = \frac{89}{880} 1000 = 86.2$
$\text{C}_3\text{H}_8(\text{NO}_3)_2$	" = $\frac{14}{148} 1000 = 84.3$
$\text{C}_4\text{H}_8(\text{NO}_3)_2 + 4\text{C}_4\text{H}_7(\text{NO}_2)(\text{NO}_3)_2$	" = $\frac{89}{1074} 1000 = 83.7$
$\text{C}_5\text{H}_{10}(\text{NO}_3)_2 + 4\text{C}_5\text{H}_8(\text{NO}_2)_2(\text{NO}_3)_2$	" = $\frac{110}{1336} 1000 = 82.7$
etc., etc.	

The possible, yet up to the present, hypothetical, nitric ethers of nitro-glucol, although capable of developing large values of

* Considered by themselves these ethers of diatomic limiting (saturated) alcohols $\text{C}_n\text{H}_{2n}(\text{NO}_3)_2$ consume into CO and H_2O only for $n=3$. For greater values of n there is a deficiency in oxygen; for $n=2$, an excess. We have chosen them as an example on account of their slight volatility, and because they approximate in composition to nitro-glycerine and nitro-mannite.

V_{1000} , and adaptable on account of their non-volatility, possess no advantages over derivatives of the higher alcohols, such as glycerine and mannite, materials that are readily obtainable, as they are widely disseminated throughout nature. We shall therefore fix our attention upon the latter; first, as they present in their analogues substances extremely rich in hydrogen, capable of producing large values of V_{1000} ; second, because they are easily reacted upon by nitric acid, forming the explosive compound ethers, nitro-glycerine, $C_3H_5(NO_2)_3 = C_3H_5N_3O_9$, and nitro-mannite, $C_6H_8(NO_2)_6O_6 = C_6H_8N_6O_{18}$. Both of these nitro-derivatives are easily prepared. The former was first employed as an explosive by the renowned Russian chemist N. N. Zinin, at the time of the Crimean war, and subsequently by V. F. Petrushevski in the 'sixties, before the discovery and very general employment of Nobel's dynamite and other nitro-glycerine preparations; the cause of their general use being the ease with which the base material—glycerine—was obtainable in nature, while the reaction with nitric acid (admixed with sulphuric) was easily effected; *i. e.*, the manufacturing process was a simple one.

Nitro-mannite, isolated and investigated by N. N. Sokolov, professor at the Medico-Chirurgical Academy, is also easily prepared, but not in its lower degrees of nitration. This circumstance is important for the reason that the readily manufactured nitro-glycerine and nitro-mannite are not themselves available for use in guns, although very well adapted for detonating effects. They correspond, moreover, to relatively small values of V_{1000} , as they contain an excess of oxygen:

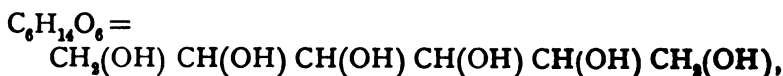


But as these substances contain an excess of oxygen, they may be admixed with others containing a deficiency thereof, which they consume, evolving carbonic oxide, and developing relatively large volumes, V_{1000} ; while by admixture with such substances low in oxygen, or not containing it, their detonating qualities may be caused to diminish, or made to vanish, as in dynamite, by combination with an inert base (tripoli, magnesia, etc.), whereby the tendency of nitro-glycerine to detonation through shock is diminished. In this manner, by admixture with a combustible substance, nitro-glycerine powders are formed. If we take Cor-

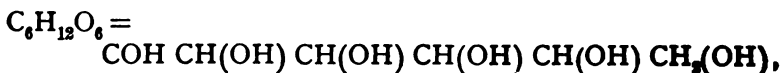
dite as an example, we find that on account of its excess of oxygen it produces a relatively small gas volume; we may, therefore, select a mixture of nitro-glycerine and collodion (assumed as $(C_6H_8(NO_2)_2O_8)$ such as Ballistite and determine for it V_{1000} on the assumption that it shall develop only CO, H_2O and N_2 .

$$\begin{aligned}
 2C_3H_5N_3O_9 + 7C_6H_8N_2O_8 &= 48CO + 33H_2O + 10N_2 \\
 \text{weight } 2.227 + 7.252 &= 48.28 + 33.18 + 10.28 = 2218 \\
 \text{volume of gases} &= 48.2 + 33.2 + 10.2 = 182 \\
 V_{1000} &= 82.1.
 \end{aligned}$$

Therefore, if nitro-glycerine powders contain only the quantity of nitro-glycerine necessary to produce H_2O and CO, then the volume of gases evolved by them is almost the same as that developed by pyro-collodion. It is evident, then, that neither nitro-glycerine, nor its mixtures when employed as smokeless powder, evolve volumes of gases greater than pyro-collodion, and that admixture with other substances, of whatever kind they may be, although homogeneous from the mechanical standpoint, are still far less homogeneous than any single substance, and that it is useless to seek for nitro-glycerine powders capable of exceeding pyro-collodion powders in point of magnitude of V_{1000} , apart from other considerations. This applies also to nitro-mannite, the source of preparation of which is far less common than glycerine, and to many of the hydrocarbons analogous thereto, as glucose, starch, cellulose, etc. If all of the six atoms of carbon in mannite are in the same combination as in the limiting (saturated) alcohols:

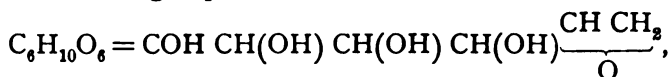


then in glucose, $C_6H_{12}O_6$, one atom of carbon should be combined as in aldehyde,



and, therefore, if mannite represents a hexa-nitrated product (compound ether as derived from an alcohol) glucose represents only a penta-nitrate. Materials such as cellulose, starch and the like, of composition $C_6H_{10}O_5$, may be regarded as the pre-

ceding alcohols,—anhydrous, arranged as follows with reference to the di-alcoholic groups,



whereby it appears that there are only three complete alcohol groups remaining out of the six in mannite. Therefore, in the latter case, we should expect to find only tri-nitrated products, which is actually what occurs. If such a scheme throws light on the matter from one standpoint (as relates to the number of hydroxyl radicals giving rise to nitric ethers) it illuminates it obliquely from another, which is of considerable importance to us. In all aldehydes, beginning with the formic and acetic, a tendency to polymerization is to be noted, due, doubtlessly, to the property of aldehydes of entering into various combinations (with H_2 , O, NaHSO_3 , etc.); whence the composition $\text{C}_6\text{H}_{10}\text{O}_6$, containing an aldehyde grouping, should also possess this property, as far as relates thereto. We may, therefore, safely assume that the molecular composition of cellulose, judging from its properties, is polymerized, *i. e.* it is of the form $\text{C}_{6n}\text{H}_{10n}\text{O}_{6n}$, where n is probably very great. If we assume $n = 5$, the cellulose becomes of composition $\text{C}_{30}\text{H}_{50}\text{O}_{25}$, and, for the highest degree of nitration, $\text{C}_{30}\text{H}_{38}(\text{NO}_2)_{15}\text{O}_{25}$. But pyro-cellulose has a composition $\text{C}_{30}\text{H}_{38}(\text{NO}_2)_{12}\text{O}_{25}$; therefore, the number of independent nitro-celluloses (nitric ethers) may be very large.

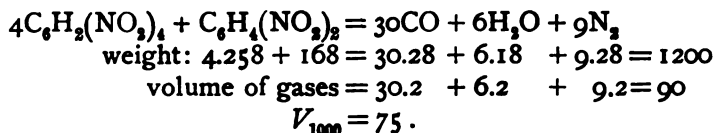
This is very important in the conception that the nitration of cellulose may be carried up to any desired degree, and for known concentrations a mixture of nitric and sulphuric acid neither dissolves nor reacts upon a product of nitration. Again, cellulose is the most widely disseminated in nature of all the hydrocarbons possessing the composition $\text{C}_6\text{H}_{10}\text{O}_6$, constituting the tissues of all plants and prepared from time immemorial in great masses as cotton, flax, paper, etc., while its products of nitration present an unalterable material suitable for conversion into smokeless powder. This side of the matter needs no further elucidation, but it must be remembered that before the development of pyro-collodion it was stated that the higher the nitration of the cellulose the higher the explosive produced, and that in manufacturing powder from highly explosive nitro-cellulose (of composition about $\text{C}_{30}\text{H}_{36}(\text{NO}_2)_{14}\text{O}_{25}$, collodion (of composition

about $C_{30}H_{40}(NO_2)_{10}O_{25}$) was added, for the reason that higher nitro-celluloses in the form of filaments or dust were easily detonated (whence their employment for mines), while the latter property was reduced or caused a disappearance after gelatinization, of which collodion was easily susceptible and for which purpose it was added. The introduction of pyro-collodion changed existing views upon the subject, showing that maximum force for nitro-cellulose was not to be sought from the highest degrees of nitration (*i. e.* for maximum content of nitrogen and oxygen), but that it obtained for that mean degree of nitration present in pyro-collodion. For the latter material $V_{1000} = 81.5$; while for nitro-cellulose of maximum nitration, $C_6H_7(NO_2)_3O_5$, $V_{1000} = 74.1$. The above represents only one side of the theoretical investigation of materials suitable for smokeless powder; but other considerations are also in accord, as will be shown later; and we have, therefore, gone considerably into detail, the more urgently since it has been necessary to struggle with prejudice, harmful to success in such a new field as that of smokeless powders.

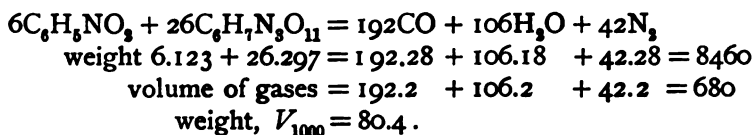
Among the possible materials proposed, apart from mixtures of such different bodies as ammonium nitrate and various organic substances (such mixtures were rejected in practice), must be considered the nitro-compounds corresponding to benzol and its derivatives, naphthalin, etc., as coal-tar constitutes an abundant source for their production in large quantities, and they are easily nitrated. From the class of the so-called "aromatic compounds" derived from benzol, C_6H_6 , it is useless to expect smokeless explosives developing large volumes of V_{1000} , although many are high explosives, beginning with Melinite or picric acid, $C_6H_3(NO_2)_3OH$, which constitutes a powerful material, although far from the best, for torpedoes and explosive shells; and since some of the first smokeless powders were mixtures containing picric acid. The cause of the small gas volumes V_{1000} developed by the aromatic compounds is due to their composition, as they are all low in hydrogen. This view may be illustrated by a few examples.

To benzol correspond bodies whose general composition may be expressed by the formula $C_6H_{6-a}(NO_2)_a$. If a equal 1, 2 or 3 (these substances are known and easily obtained), the oxygen content is insufficient to consume the carbon into CO and the hydrogen into H_2O , although explosion occurs with the formation of carbon (smoke, soot) and of hydrocarbons.

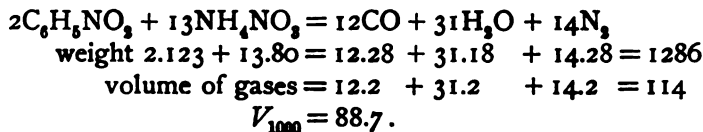
Total smokelessness could be realized from mixtures of highly nitrated products, as



If, instead of such non-existing highly nitrated benzols, pyroxylylene be employed (as in the American smokeless powders of Munroe and other inventors), a gas volume approaching that developed by pyro-collodion is realized.



The matter assumes a different aspect if ammonium nitrate NH_4NO_3 be employed for converting the carbon and hydrogen of nitro-benzol into CO and H_2O . This substance contains a large amount of hydrogen for a relatively small content of oxygen (but for this result a large amount of NH_4NO_3 must enter into the mixture), and greatly increases the volume of gas developed, as is evident from the following:



But mixtures of this salt must always be avoided if a satisfactory smokeless powder is to be produced, as it is soluble in water as well as hygroscopic, and produces with viscous oily materials only coarse mechanical mixtures.

Similar results are to be obtained from other aromatic substances, and we may refer by way of example to mixtures of pyroxylylene with picric acid, $\text{C}_6\text{H}_3(\text{NO}_2)_3\text{OH}$, and nitro-naphthalin, $\text{C}_{10}\text{H}_7(\text{NO}_2)$, as such compounds have been recently experimented with (but abandoned in practice) as smokeless powders. Among other disadvantages, they develop smaller gas volumes, V_{1000} , than pyro-collodion, on account of their relatively small content of hydrogen.

After an examination in the above manner of the composition and properties of all possible material capable of employment as smokeless powders, we arrive at the following deductions in relation to the volume of gases (measured at given temperature and pressure), V_{1000} , developed by their combustion:

1. Only substances containing nitrogen, carbon, hydrogen and oxygen are capable of entire conversion, as required for smokeless powders, into gases that do not react upon gun-metals. Hence all other explosive substances (*e. g.* fulminate of mercury, chloride of nitrogen, etc.) containing haloids, metals, phosphorus, etc., are unsuitable for use in gunpowders.

2. When the combustion of carbon results in the formation of carbonic acid gas, CO_2 , a less volume of gas is formed than when carbonic oxide, CO , is the resultant product, and as the former requires more oxygen than the latter, the increase of oxygen or nitrogen (if, as is usually the case, the oxygen enters into combination with the aid of the elements of nitric acid) is injurious, instead of useful, although there exists full conversion into gases as is required for smokeless powder.

3. The greater the quantity of hydrogen in the powder, other conditions being equal, the greater the gas volume, V_{1000} , corresponding to the combustion of the powder, and, therefore, substances derived from the limiting (saturated) series of hydrocarbons are more suitable than bodies of the "aromatic" series for smokeless powders.

4. Not any of those explosive materials not containing carbon (as N_3H , NH_4NO_2), that evolve large volumes of gas V_{1000} and decompose upon ignition, are such that will not detonate, *i. e.* evolve their gases so rapidly that they crush the walls of guns; whence it is useless to consider them as materials adaptable for conversion into smokeless powders.

5. Some of the materials containing but little carbon and much hydrogen may prove suitable for use as powders or powder mixtures, evolving large volumes of gas upon combustion; but, so far as known, they are either volatile or liable to decompose spontaneously and detonate, or else they are prepared with difficulty from mixtures not widely disseminated, so that at present it is useless to look for materials for smokeless powder from among them.

6. Nitro-glycerine itself develops but a small gas volume

($V_{1000} = 63.9$) as it contains an excess of oxygen. It may be employed in mixtures to form smokeless powder, and its mixtures with nitro-cellulose, such as Cordite and Ballistite, which are practically homogeneous from a physical standpoint, develop gas volumes V_{1000} , a little less than that evolved by pyro-collodion (although such mixtures erode guns, as already stated).

7. Cellulose, $C_{6n}H_{10n}O_{5n}$, is a substance widely disseminated in nature and of general industrial employment; by its non-volatility, insolubility, durability, etc., and by the readiness with which it is nitrated (as it contains much hydrogen), it constitutes a superior base for smokeless powders.

8. Among all the forms of nitro-cellulose capable of smokeless combustion, the maximum gas volume V_{1000} corresponds to $C_{80}H_{88}N_{12}O_{49}$ ($= 12.44$ per cent. nitrogen), which is pyro-collodion, for which $V_{1000} = 81.5$, and which is capable of complete gelatinization in a mixture of ether and alcohol, in which form it is completely free from any tendency to detonate. In the first place, it is the most suitable of all the nitro-celluloses; in the second, it is the most rational and readily obtainable form of smokeless powder, destined to supplant not only other smokeless powders, but also to replace, by reason of its greater homogeneity and its combination of qualities, other pyroxylyne powders.

Pyroxylyne powder is a mixture of nitro-celluloses, of higher nitration, such as $C_6H_7(NO_2)_3O_5$ and of lower, as $C_6H_8(NO_2)_2O_5$; pyro-collodion is a definite homogeneous single form of nitro-cellulose. By changing the proportional relation of contents of the high, or insoluble, and low, or soluble nitro-cellulose, it is evidently possible to make the pyroxylyne approach the pyro-collodion powders; but (as has been shown in recent years, especially in cannon powders) the limit of improvement of these forms always falls short of pyro-collodion. The latter is homogeneous and unchangeable, while pyroxylyne powders vary according to their composition. However, from its origin it is in no wise different from the perfected powder of Vieille (although considerably different from the original form thereof) presenting instead of a mixture, from the chemical and mechanical standpoint, a homogeneous limiting mass of the composition $C_{80}H_{88}N_{12}O_{49}$, which is required in order that the powder may create upon combustion the maximum volume of vapor and gases. It is certain that henceforth pyroxylyne powder will continue to approximate

to the pyro-collodion until the two become identical. In brief, pyro-collodion represents the Russian limit of modification and improvement of the French pyroxylene powders, the development of which marked an epoch in ordnance progress, but which has not hitherto presented an invariable and constant relation of the elements entering into its composition. In this light pyro-collodion powder may well be styled Franco-Russian. Begun in France, it has been completed in Russia.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

DISEASES OF ELECTRICAL INSTALLATION IN THE
NAVY.

THEIR CAUSES AND REMEDIES.

By LIEUTENANT B. T. WALLING, U. S. N.

(From lectures delivered before the U. S. Naval War College—*Concluded
from No. 86.*)

Fig. 31 is a correction to Fig. 17 which inadvertence in transmission is made to represent a C. type engine. Fig. 17 properly represents a B. type engine and all references heretofore made to that figure should be referred to Fig. 31.

FIXTURES.

The contemplated changes in design are merely those in smaller details for better degree of water-tightness; the general idea of the devices seems to be in the main satisfactory.

Portable.—The most troublesome fixture, in so far as continuity of service is concerned, is the very convenient and much used portable. The chief disadvantage of Portable No. 5, Fig. 32, is its want of water-tightness, for which a globe seems to be the only solution, and which has been introduced in the especial type, Portable A, shown in Fig. 33. A third type, Portable B, shown in Fig. 34, is now issued for coal-bunker use.

Portable A is necessarily heavy and the globe can easily be broken. No. 5 is to be preferred for uses where water-tightness is not desired.

Presuming a portable to be properly wired up (a job requiring much patience and a skillful hand) the lack of water-tightness, particularly for fire-room and double bottom use, where the fixture receives its hardest usage and is most exposed to mois-

ture, occasions many of the grounds that cause the flickering of the ground-detector lights and give rise to the remark, so often heard in dynamo rooms, that the ground-detector will generally announce the turning on of a fire-room portable.

In practice the lack of water-tightness becomes but one of the evils which cause the grounds; the others are:

1. The construction of the double conductor used.

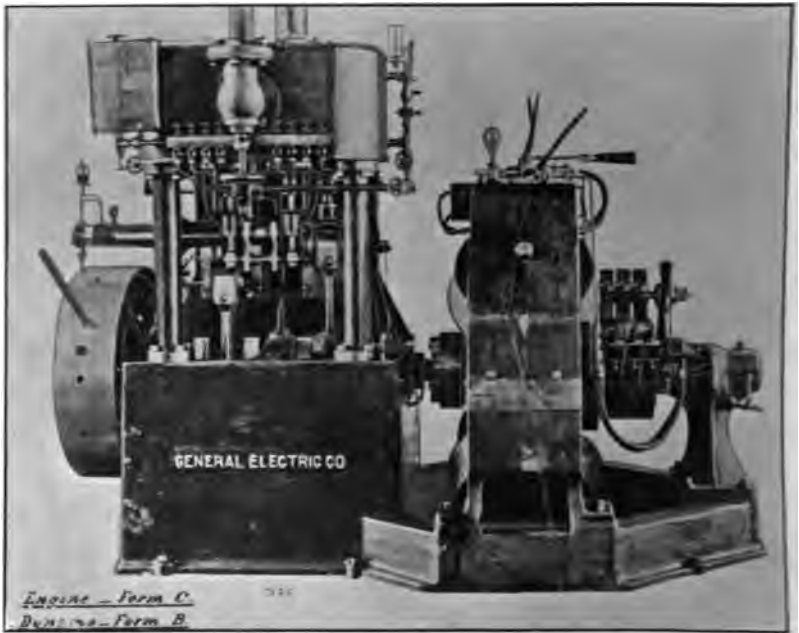


FIG. 31.

2. Mechanical injury by those using the portable.

The concentric double conductor (hemp portable) heretofore in use has never assured good or efficient wiring; in fact, its greater flexibility may be a doubtful advantage over its difficult manipulation in overcoming grounds. Each strand was composed of 28 number 20 B. W. G. wires, so small and brittle that they easily fringed out in twisting, and, as one strand must be bared in order to wire up the socket, the fringe easily grounded the metal base. At the plug end of the conductor another

difficulty presented itself in that the wires, when twisted, were so bulky as to prevent the contact screws from setting home and to the extent that the screw head had to be filed down (in order to enter the collar) and became too weak for good service. This is a common fault with this work when done on board ship.

The latest construction has seven No. 25 B. & S. G. wires laid concentrically, which overcomes the fringing tendency; the excessive bulk of the twisted strands (under the contact screws of the plug) can be eliminated by splitting the strand into two parts and laying the parts flat under the screw-head. This



FIG. 32.



FIG. 33.

method is much lost sight of when wiring is done on ship-board and is an inflexible rule for proper workmanship.

Our original twin conductor, consisting of two insulated wires protected by braiding, is probably the best solution of the construction of double conductor, plain; it is less flexible as compared with other designs, but it is easy of manipulation, efficient and cheap.

Mechanical injury by those who are using the portable manifests itself in the wholesale breakage of attachment plugs, amounting in one ship to sixty, in a period of four months.

Inserting a plug into its receptacle demands no skill; it simply requires that the plug be carefully pushed into place with one hand and secured by screwing on the collar with the other hand. As practiced, attempt is made to do both operations with the same hand, the rubber plug is twisted and broken, which short-circuits the lamp or occasions grounding to the receptacle box. It has been suggested that much of the breakage mentioned can be avoided by constructing the plug of oak or other hard wood, a suggestion that is to be recommended and should be adopted. Breakage of attachment plug occurs as well wherever they are used for receptacles, but that of portable use is much in excess.



FIG. 34.

A peculiar instance of the use of attachment plugs was brought to notice in a complaint that those furnished the ship would not operate. It was found that the portables had been wired up to *25-ampere plugs* instead of to 5-ampere plugs.

Referring to Fig. 35, it will be seen that the *25-ampere plug* is not double pole and, therefore, it short-circuits the lamp when inserted in a 5-ampere receptacle. The lamp cannot burn and an unnecessary extra load to the dynamo is the result of the thoughtless error.

Ceiling Fixtures.—This type of fixture has its main fault in the scaling of the reflecting surface due to the heat of the lamp. Properly this reflecting surface should be a hard enamel on iron, a construction now quite common.

The reflecting surfaces can be kept in efficient order by the occasional use of enamel paint; this paint is cheap, is common commercially and serves another good purpose as a means of a touching up the outside of the rings of silver fixtures when the plating becomes worn.

Bronze rings, junction boxes, switches, etc., are best kept in neat order by the use of black varnish or asphaltum applied at least once a quarter.

Wires to ceiling fixture sockets should never be led through holes bored in the side of the socket as such practice vitiates the water-tightness.

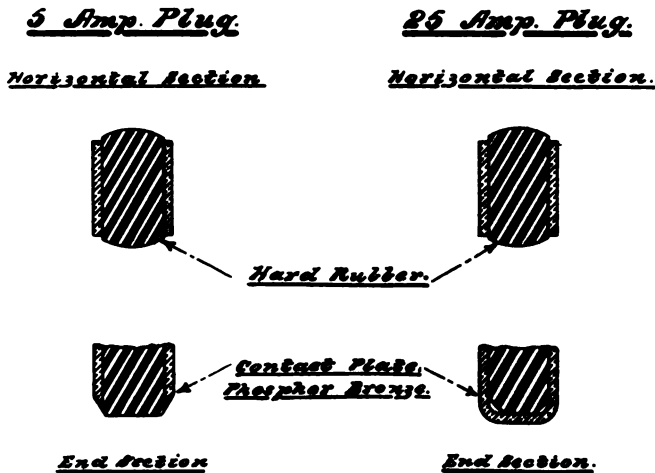


FIG. 35.

To insure against the admission of moisture care should be taken that the globes are always screwed firmly against their rubber rings. Frequent cases of corrosion of sockets and contacts occur from neglect of this injunction.

Steam-tight Fixture.—The usual difficulty with this fixture is abnormal breakage of globes due to want of provision of guards in exposed locations. The guarded fixture should always be installed where there is the slightest liability to accident or mechanical injury and is practically imperative in boiler and machinery spaces, their connections, and where tools are to be used. The nature of the use of this fixture makes it an especial case of a tight fit of globes against their rubber rings.

Diving Lamp.—This device has usually met with many difficulties. It is particularly exposed to short circuit from breaking of insulation due to the rough handling by a diver who is otherwise much encumbered.



FIG. 36.

Fig. 36 shows the present fixture with its incandescent lamp of 150 c. p., and also a spring device which has proved successful in preventing nips, which cause the breakage of insulation at the handle of the lamp, at which point the ground or short circuit occurs.

Bulkhead Bunker.—The two difficulties met with are breaking of the glass and want of water-tightness, the latter usually the

result of the former. The difficulty has never been overcome and can probably only be remedied by a new design. The expedient of securing the globe flange with felt and red lead does not make a water-tight joint as the mass hardens and breaks away from the glass. It seems necessary that the globes should be jointed with rubber rings and to accomplish this the flanges must be truly parallel, a matter almost impracticable with glass-makers; grinding the flanges to parallelism breaks the skin of the glass and introduces a plane of weakness just as breaking the skin of a rolled shaft weakens the shaft at that point. The present design



FIG. 37.

of globe is advantageous on account of the better dispersion of light.

The better distribution of these bunker globes will in the future remove many troubles of bad lighting that have been complained of by the engineers, especially near the doors leading into the fire-room. Portable B will afford much assistance in this respect.

A new type of fixture, shown in Fig. 37, is installed in the Chicago.

Desk Light.—The present pattern seems to fulfill a majority of

the needed requirements. Present specifications require that **cup hooks** and a new hook of square section shall be provided in convenient places for hanging the light.



FIG. 38.—DOUBLE TRUCK LIGHT.

Truck Light.—Fig. 38 shows the present type in use; the **masts** to be provided are mentioned in the specifications.

This light is a continual source of repair, not in the **fixture** itself but in the wiring on the mast. The source of the **difficulty**

can commonly be found in the connections on the topmast near the light, or in those of the receptacle box placed at the bibbs or near the top.

The leads for truck lights should in all cases be double conductor, plain wire led in conduit to the receptacle box. The topmast lead should be in a score in the back of the mast (especially in those ships in which the topmasts do not house) and



FIG. 39.

should be carefully covered in. Objection has been made to scoring topmasts on account of the tendency to weaken the mast, but the objection cannot be considered to be well taken in this connection and would certainly alleviate, if it did not remove, the great majority of the difficulties met with. The wiring is otherwise much exposed to weather.

One of the recent improvements in truck light manipulation

has been the introduction of a controller, located on the bridge, by which both the lights of both masts can be operated from the same pedestal by a single lever. It is shown in Fig. 39. It is practically free from the effects of weather on the connections.

Mechanical Engine Room Telegraph. (Annunciator.)—The method of lighting with oil has been unsatisfactory, and many of the fixtures have recently been improved by leading wires to a receptacle on the pedestal and using an electric light which is designed to fit in the slide provided for the lamp. The design is shown in Fig. 40. The lamp used in this fixture is 5 c. p. at 80 volts.



FIG. 40.

Electroliers.—These fixtures have been provided as a relief to the inefficient lighting over ward room tables; a two-light fore-and-aft branch will be found most satisfactory. Drop lights should ordinarily be desk lights; a two-branch bracket will prove a satisfactory reading light.

Battle Lanterns and Deck Lanterns.—The difficulties usually complained of are found at the plug (as explained under portable) and grounds in the exposed receptacle boxes; the fixtures themselves rarely give trouble with reasonable wear.

Fig. 41 shows the present type of battle lantern on its bracket with the hook for the bight of the conductor.

Search Lights.—The first fault of search lights resides in the use of an inclined lamp.

1. From the weight which is required to be lifted by the "striking arc" (series) magnet in excess of its real function of merely separating the carbons. Any mechanical resistance which is introduced, such as friction, dirt from carbons, etc., interferes



FIG. 41.

with successful working; the series magnet is unable to separate the carbons, and a prolonged short circuit with small resistance ensues which overloads the dynamo or fuses the main contacts in the pedestal.

2. The fragile lava insulators continually break, short-circuiting the system. While lava is, perhaps, the cheapest and most efficient method of insulation, the numerous types of washers

necessary to the device continually break and are very troublesome to replace, proving a continual source of annoyance.

3. Fusing of the contact plungers of the pedestal whose office is to make connection from the contact rings of the base to the main contacts for the lamp. When this fusing takes place the pedestal becomes locked and cannot revolve. It is commonly caused by the non-separation of the carbons, either from failure of operation of the mechanism or the adherence of the carbons due to the formation of a mushroom on the negative carbon.

The mushroom appears as a small protuberance on the end of



FIG. 42.

the carbon and is of a pasty consistency. It can readily be removed by the edge of a file or screwdriver and ordinary attention to the working of the lamp should guard against its formation. In most cases the carbons will adhere if a mushroom forms.

The remedy for the fusion of plungers is shown in Fig. 42, a method of repair that has been successfully practiced in several ships. It consists of a phosphor bronze spring, *A*, in which are set brass blocks or brushes, *B*, the springs being secured to micanite insulators. The brushes take against the contact rings in the base of the pedestal and afford a much larger contact surface.

In the latest projectors the contact rings are made a part of the *pedestal*, the plungers being placed in the base; this relieves, though it does not obviate, the difficulty.

The inclined lamp has been replaced by a horizontal type, constructed somewhat on the Schuckert principle. Figs. 43 and 44 show two views of the latest type for 30-inch, type H, projectors. The design is similar for all projector sizes. Newer designs show slight changes in mechanical construction.

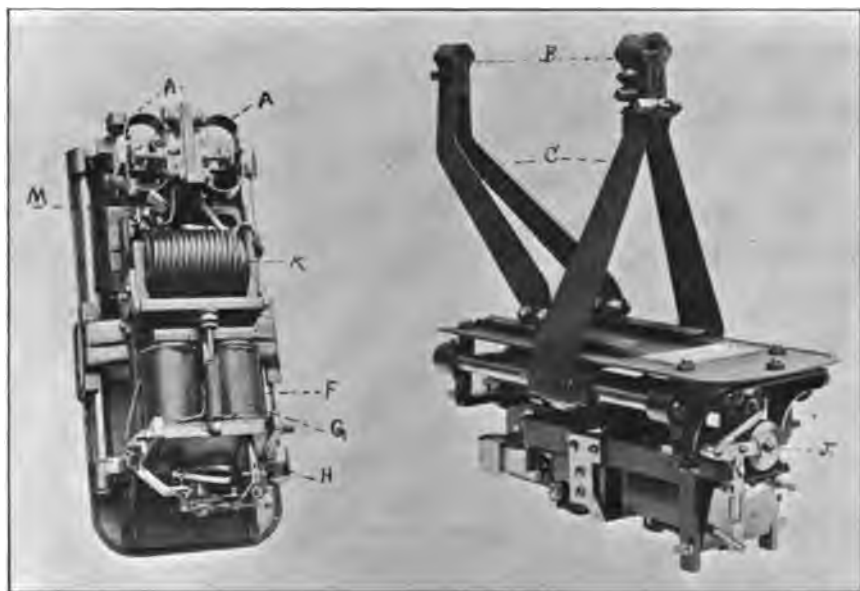


FIG. 43.

FIG. 44.

The springs, *A*, take current from leads to the contact rings of the pedestal (to the plungers in older types), the path of the current being shown in Fig. 45.

The carbons are secured in clamps, *B*, on supports, *C*, the supports being movable in guides of the frame and controlled by screw-bars, *D* and *E*. The larger clamp is for the positive carbon, in which the crater is formed and which will therefore be the farther clamp from the projector mirror. *F* is the automatic feed, shunted from the lamp leads, having an electromagnet, *G*, which controls the armature, *H*, and which in turn operates the

screw-bars *D* and *E*, through a pawl ratchet and gearing, *J*, when the voltage in the magnet is above 50 to 52 volts. *K* is the series

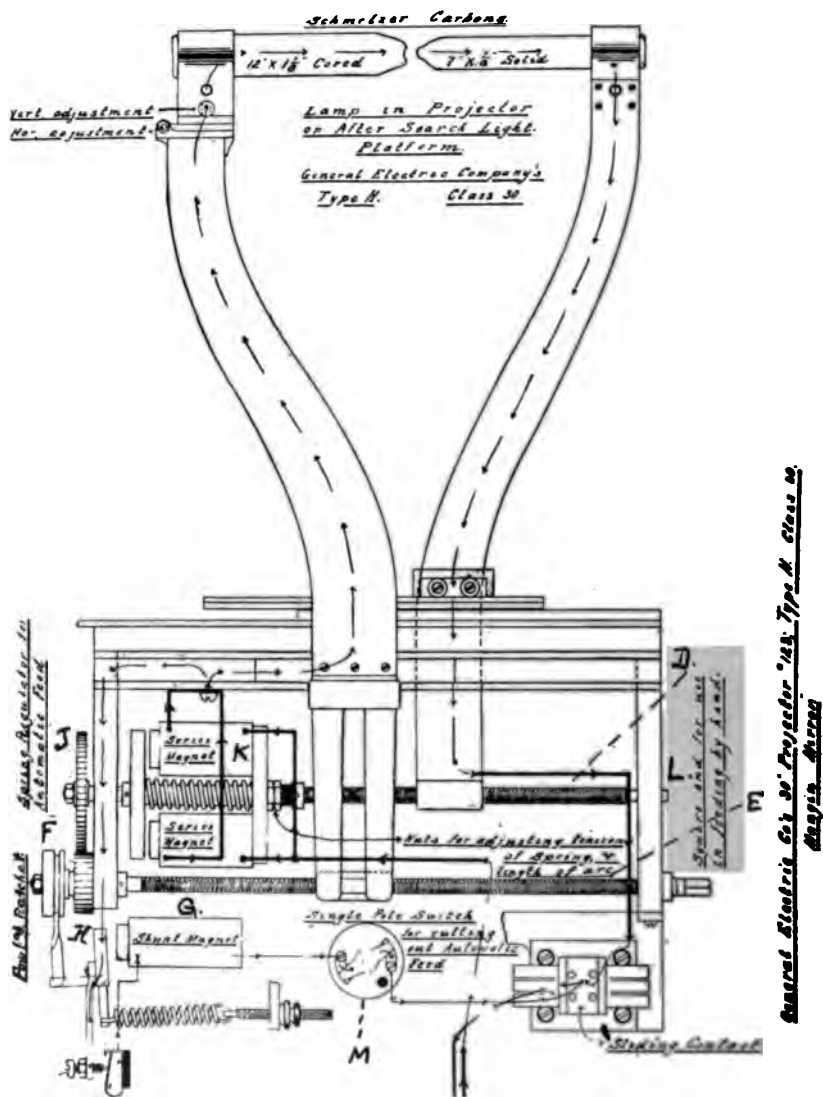


FIG. 45.

striking arc magnet which operates only when the current is much in excess of that required for the lamp. A lug on its

armature embraces the screw-bar, *D*, between two collars, the screw-bar having a small play at *L*, which is independent of the control of the automatic feed. Owing to the gearing the screw-bar, *D*, revolves but one-half as fast as *E*. The screw-bar, *E*, can be turned by a crank socket-wrench, which is removable and can be fitted on a square post at the rear end of the lamp. [Figs. 43 and 44 do not exactly correspond to Fig. 45 owing to differences of construction of the two constructions represented.]

The method of operation is this:

The carbons are adjusted by the crank-wrench to a separating distance of about half an inch. The automatic switch, *M*, should now be closed. The main switch is closed next and, as no current can pass until the carbons touch, the voltage across the carbons up to that moment must be 80 volts. The shunt magnet (called the feed) commences to vibrate, the voltage being greater than 52 volts, and feeds the carbons together by means of the pawl and the gearwheels of the screw-bars. When the carbons touch a heavy momentary current passes (since the resistance is small and voltage at 80), the armature of the striking arc magnet is attracted, pushes back the negative screw-bar and forms ("strikes") the arc. The resistance of the rheostat causes a drop of from 20 to 30 volts as soon as the current passes, and should be adjusted by the lever to the voltage necessary for running the lamp without flaming and hissing.* The voltage required in practice is usually from 45 to 49 volts; the feed will frequently operate at 50 volts. The working current for the lamp varies with the size of the lamp and, incidentally, with the size of the carbons; it is as great as 75 to 90 amperes for the 30-inch projectors, and from 25 to 35 amperes for the 18-inch type.

There is often some flaming of the carbons which cannot be controlled by the rheostat; it is unimportant except from the fact that it decreases the intensity of the light; it will usually disappear of itself. Horizontal lamps have a tendency to flame at the upper edge of the crater, thereby forming the crater on the upper edge of the positive carbon and distorting the reflection; this tendency is corrected in our projectors by a horse-shoe

* The rheostat forms a dead resistance in the line, causing a drop (current multiplied by resistance) equivalent to 30 volts, at which 10 volts are adjustable by the rheostat lever.

magnet, attached to the diaphragm in the projector, which draws down the arc by magnetic attraction.

Some hissing will occur when starting up, especially with new carbons, and the lamp will not quiet down until a good crater has been formed in the positive carbon. This can be obviated by reaming out a crater in the positive carbon with a penknife before putting it in the clamp.

Flaming and hissing are promoted by inferior carbons and are much increased if the carbons have absorbed oil. Those now provided are of the Schmelzer manufacture and are very homogeneous; the positive carbon is usually bored axially and cored with a soft carbon, which materially assists in maintaining a good crater. Negative carbons are sometimes cored, but it is an open question whether this expedient does not conduce to the formation of mushrooms.

Heretofore the carbons were furnished in paper-covered packages which exposed them to moisture and oil, which are readily absorbed by the porous material; they are now packed in tins and should be kept covered and stowed in the store-room.

The momentary current of short circuit, when the carbons touch, is ordinarily heavy and quite sufficient to throw the pointer of the ammeter clear across the scale and against the stops; it need occasion no apprehension if it does not continue; if it does, the switch at the switchboard should be quickly opened. This current may be as much as 50 per cent. above the working current.

Any abnormal current of the searchlight ammeter is usually traceable to either a mushroom on the negative carbon or careless handling of the socket-wrench. In most cases of fusing of the contact plungers in the pedestal there has been direct evidence of an attempt to regulate the feed by hand when the automatic gear was switched on. If the lamp does not feed it is for the reason that there has been a burn-out, or that the lamp itself is not clean, and in 90 per cent. of the cases dirt is the cause; any attempt to remedy matters by use of a socket-wrench, while the current is on, is quite sure to short-circuit the lamp and produce overload.

As a rule it is better to set the carbons before or permit no use of the wrench except in focussing; no good may be the man who ordinarily manages the proje

other man is quite sure to come along and do the mischief; it is the other man who is so untraceable in accidents. The automatic feed is a very desirable expedient and will give good report of itself if not impeded by an impatient use of the socket-wrench. There is rarely any occasion for using the wrench on the *screw-bar* after the lamp is in operation.

The key to good search-light operation and management is thorough cleanliness in all the parts and frequent opportunity for practice by those who are not ordinarily called upon.

The mirrors will spot or frost in time; the action is much hastened on board ship by the practice of exposing them to the



FIG. 46.

rays of the sun while drying out the barrel. There is nothing that will so quickly ruin the silvered surface of a mirror as the action of direct sunlight.

The breakage of front door glasses seems rather more frequent than should be necessary, but, as a rule, it is the result of accident. The glasses are now furnished in strips and effort is being made to have the same number of strips for all front doors irrespective of diameter of projector, in order that they may be supplied on requisition from a mere statement of the type of the projector and the number of the strip. With those now installed the glass-makers cannot intelligently carry out the order unless

a diagram of the whole front, with the dimensions, is furnished from the ship.

Every projector-front should be fitted with an extra outside door made of perforated fibre for the protection of the front glasses. They have been supplied thus far to but one or two ships and on the design of Fig. 46.

Diverging lenses are now plano-convex in the horizontal plane only. The door is made in strips similar to that having the plain glass, each strip being a plano-convex lens.

Parabolic mirrors are now replacing the Mangin type. The Mangin is a double convex lens which is silvered on the back. It has the advantage that for a given focal length the rays of light which it receives are first concentrated on the mirrored surface before reflection. Its disadvantage is that for a given aperture it throws less light than even a concave mirror.

The disadvantage of the concave mirror is the apparently smaller intensity of beam as compared with either the lens or parabolic types. *As looked at by the operator the intensity of the light thrown on a target appears greater for both of these latter styles than for the concave, and is greatest for the parabolic.* When examined photometrically at the target it will be found that the intensity of the lens mirror is less than that of either the concave or parabolic, while the intensity of the concave and parabolic is practically equal.

The discrepancy, as viewed by the operator, is caused by the fact that concave mirrors throw out a conical penumbra around the beam which interferes with clear vision at the projector, and the illumination of the target appears to be less than that of either the lens or parabolic mirrors.

The parabolic mirror is the most advantageous for searchlight use for the great reason that it lights up the foreground better, and, as we are accustomed to outlining objects by their surroundings, the target is brought out with more sharpness and distinctness of detail. Fig. 47 shows the present style of projector and accessories.

Night Signaling Set.—This device, more commonly known as the ardois, developed an annoying series of faults in the key-board, due to defective contact of the plungers. In later key-boards, semi-circular in shape and designed for the change from five to four lamps, little fault has been found, and, as a rule, little

trouble is occasioned apart from the slow action of the device. Some difficulty, ordinarily short circuit, is met with at the point where the cable enters the gland of the coupling at the keyboard. It is usually a ground due to breaking of the insulation by a nip and is best remedied by the spring connection for the diving lamp shown in Fig. 36.

More frequently troubles are met with in the cable couplings



FIG. 47.

themselves. The cables have been made in three sections of 50 feet each, a lamp section from which the wire is branched to the lamp and two plain sections. Each plain section is provided with a male and female coupling in which the contacts are made for the separate wires of the cable, a guide and pin insuring proper entrance. The lamp section has a female coupling only. Although fitted with secure water-tight gaskets water often works into the inner chamber of the coupling and short-circuits

the contacts. Covering with painted canvas is only tentative and has a further disadvantage in that it holds in the water when it has entered.

There is no real necessity for more than one coupling on the entire cable and it should be the female coupling at the lower end for the keyboard connection. It will be found more satisfactory and quite as serviceable to cut off the two upper couplings on all cables having three couplings, splice the wires and tape the junctions water-tight.

On board of the *Indiana*, where experiments were made with the couplings, the cable was led to and inside of the military mast, thus protecting all couplings from the weather, except that at the keyboard. Particular attention was paid to making the coupling of the lamp section thoroughly tight, but in a short time it was again found to be full of water. Investigation showed that the water had gotten inside the cable through the joints where the lamp wires branch out; once inside, the water was drawn through the cable by capillary attraction, and then into the coupling; the amount of water so drawn made it necessary to bore a very undesirable hole in the bight of the cable outside of the mast to act as a drain. As an emphatic repetition it can be said that one coupling at the keyboard is all that is necessary, and the quick, sure remedy for troubles with other couplings is to take them off.

There seems to be no successful way of preventing the deterioration of the cable due to the heat of the smokepipe; the only resort is a new piece of cable.

One or two cases of filling the upper part of a lamp with water have been noted. This ought not to occur if the gaskets and lenses are tight. A simple method of obviating the difficulty is to bore a small hole in the diaphragm at the bottom of the lamp and out near the edge where there will be no chance of transmission of light. With this arrangement the lamp ought to drain well.

The keyboards have often been inconveniently placed and should preferably be clamped on the bridge-rail within easy access of the officer of the deck. This will require protection to the keyboard by a hood fitted with a sliding door, of which a nice device is shown (attached to the bridge-rail) in Fig. 48, and is for the semi-circular type of keyboard. No good design of

hood for the circular keyboard has been devised; the main difficulty is that in applying the design of Fig. 48, the hood would be too tall, cumbersome and unwieldy.



FIG. 48.

The desire for a more rapid system of signaling has led to the introduction of the telephotos, shown in Fig. 49, in which the contacts are made by a vertical plunger, whose cap fits over a sleeve and keeps the water out. Merely pressing down the

plunger makes the display for that letter or number, and the time lost in adjusting a lever to the required spot and then switching in the current, as required for the ardois, is obviated. The instrument is mounted on a pedestal and well covered by its hood, within which a lamp is placed. The cable is merely a



F.G. 49.

bundle of wires in a canvas tube wrapped outside with a wire armor.

A set of balls in a trough under the plungers prevents the making of two displays at the same time.

It works well, and the rapidity with which signaling can be done is well up to practical requirements.

Rheostats.—The burning out of rheostats is most frequently caused by a misapprehension of their office. It is popularly said and supposed that a rheostat is for the purpose of cutting down the current which is entering the device with which it is connected, and the argument is bolstered up by the triangular reasoning obtainable from the volt, the ohm and the ampere of Ohm's law. But cutting down the current is the effect of a cause, and that cause is that the voltage is cut down; the current drops in consequence. The resistance produces a drop, fall of potential, numerically equal to that resistance multiplied by the current passing.

This is easily demonstrated in the case of the shunt rheostat used with the dynamo; a voltmeter will always show that the voltage across the wires *entering the field* is seldom greater than 40 to 70 volts for an 80-volt machine of any size. The 10 to 40 volts lost in circuit are mainly due to the drop in the rheostat.*

We employ three types of rheostats:

Controllers, or regulating rheostats, used for turrets, ammunition hoist and ventilating motors (and, in a sense, the shunt rheostat) which regulate by variation of resistance.

* No matter what scientists may say as to the strictness of the analogy between the generator, wiring and electricity as paralleled with the pump, its piping and water, we can bridge over many a knotty point in electrical questions by carrying the analogy to its limit, and the application is various: electromotive force, or voltage, the force or pressure which moves electricity, as compared with pump pressure; the effects of grounds with leaks; of pipe ramifications with circuits; of friction with resistance; the cutting down of pressure by large release; bursting from want of capacity with burning-out; rheostats, with pipe expansion, pipe contraction or valves; all show the main point of the analogy. In dealing with electricity, the simple thoroughfare is to consider it from the standpoint of voltage, pressure, alone and leave out all question of current until we are brought face to face with problems of energy.

What is a volt? An ohm? An ampere? are questions that scientists have not exactly informed us about yet.

We can grasp the fact that a volt is a unit of the kind of pressure that will move a certain quantity of electricity, and that an ampere is a unit quantity of electricity. In most cases, if we get the pressure we will get the quantity of electricity we want as we do a quantity of water from a pump and, in the end, we are not so much concerned always as to *what* the amount of that quantity really is as long as our pipe or wire has the necessary capacity. There are some exceptions, where current must be considered, but they can readily be isolated.

Starting rheostats, used with motors to control the entering voltage when starting, but not intended in any way for either regulation or control of the speed.

Line rheostats, used for tapping off a reduced voltage from the dynamo mains, and used mainly with instruments.

The distinction between a controller and a starting rheostat should be especially remembered as it is of great importance in motor use.

The burning out of *line rheostats* is caused chiefly by grounds in the dynamo circuit, and can be obviated by inserting a large resistance between the contacts of the main line and those used

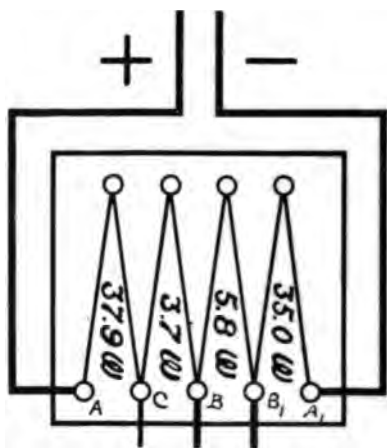


FIG. 50.



FIG. 51.

for the instrument leads. An ingenious device of the kind is used with the range-finder and shown in Fig. 50. It is required to tap off about 6 volts for the range-finder, and 4 volts for the telephone. *A, A* are the binding posts for the wires leading to the junction box of a lighting circuit. The total resistance of the rheostat wire is 80 ohms (82.4 ohms as shown) which on an 80-volt circuit gives a ready means of obtaining one volt. *B, B*, are the binding posts for the instrument wires; *C* is the binding post for the telephone whose negative wire is attached to that leading back through *B*. Between *A* and *C* the rheostat wire has a resistance of 37.9 ohms, between *C* and *B* of 3.7 ohms, between *B* and *B*₁ of 5.8 ohms, and between *B*₁ and *A* of 35.0

ohms. Hence 3.7 volts are tapped off between *C* and *B*, 5.8 volts between *B* and *B*₁, and there is a drop of 38 volts between *A* and *C*, and of 35 volts between *A* and *B*.

This arrangement of the large resistances evidently gives a great protection from any overload in the main line as compared with any other place on the resistance wire of the rheostats that the binding posts *C*, *B*, and *B* could be placed. A similar arrangement should be followed whenever rheostats are placed in a line.

Much improvement has been made of late in line rheostats and the types that can be especially recommended are those of the Carpenter designs shown in Fig. 51. These usually have a ribbed plate of cast iron on the unribbed side of which is the resistance wire embedded in enamel. The wire is first put in place, then covered with enamel powder and baked at a high temperature. The radiating surface is very large. The device has the advantage over coil rheostats in that the enamel protects the wire from burning out by radiating the excess of heat on the same principle that water in a pan on a stove prevents the fusing of the solder.

In common parlance the shunt rheostat is called "the box," probably as a distinction from other rheostats. Starting rheostats are usually spoken of as "starting boxes."

The burning out of starting rheostats is explained under the head of motors.

Motors.—The extension of motor use in our ships will require a better knowledge of that device on the part of dynamo men than that which we usually find. They seem to understand the fact that a motor is a dynamo worked backwards, and that the general cycle of operations is reversed, yet they will cause heavy sparking by rocking the brushes *forward* instead of *backward*, and regard the sparking as some peculiarity associated with back electromotive force or other hidden trouble inherent in motors generally.

Motors are tersely and excellently discussed in an article, written for the Institute in 1893, by Lieutenant J. B. Murdock, U. S. Navy. He says:

"All motors on shipboard will naturally fall under the head of constant potential motors, supplied from the ship's mains, and either series or shunt may be used. The series motor is valuable

for its great starting torque,* but has the disadvantage of an irregular speed. In many cases, as in training guns or in other heavy work, steady speed is of no consequence, while the ability to start with a heavy load is all essential. For work of this kind the series motor is the best. If thrown in circuit directly across the mains, it might burn out, the resistance being so low as to allow of an enormous current passing when the motor is at rest. As soon as it commences to move, the current is reduced to safe limits by the counter electromotive force. It is advisable, however, to interpose some resistance to save the motor, this being generally in a starting rheostat, the speed of rotation when once in motion being similarly controlled by resistance. An objection to the series motor is the fact that the speed rises dangerously high if the load is thrown off, the excitation being diminished by the rise of the counter-electromotive force of the motor. The motor makes the vain attempt to attain a speed at which its counter-electromotive force equals the difference of potential of the mains, each increase of speed diminishing the field current and counter-electromotive force and calling for higher speed to attain the voltage of the mains. Theoretically the speed of the series motor under such circumstances is infinite, but the practical limit is found in the fact that friction and internal losses always make something of a load, so that no motor ever runs absolutely light.

"The shunt motor, when made with low armature resistance, preserves a practically constant speed with wide variations of load. It possesses, however, the great defect of having no starting torque. The field coils and armature being in parallel, the former are short-circuited by the latter, and if the motor is suddenly thrown into circuit, the field would not receive enough current to magnetize it, while the armature would probably be burned out by the excess of current passing. Some special starting device is therefore necessary, and a starting rheostat is commonly provided, by which a current is passed through the field coils before the armature circuit is closed at all. The next step is to send the current through the armature in series with a resistance, the latter being gradually cut out as the counter-electromotive force rises from the speed increasing. The special

* Torque is most simply defined as the mechanical couple, due to the forces on both sides, tending to turn the armature.—B. T. W.

purpose for which the shunt motor is adapted is, therefore, starting with a light load and afterwards preserving an approximately constant speed.

"The apparent paradox that the speed of a motor is increased by weakening the field and consequently the counter-electromotive force, must always be borne in mind in considering the speed of motors. The fact that the shunt field remains excited when all load is thrown off keeps the speed down to near its normal value. If the speed could increase, the field being kept constant, the counter-electromotive force of the armature would rise until it reached the potential of the mains. It could, of course, go no higher without running the generator as a motor. The actual limit attained is less than that of the mains, as there is always internal loss and mechanical friction in the motor, energy to overcome which must be derived from the mains, and the speed settles at such a point as to allow the motor to receive just this amount of energy.

"The foregoing is sufficient to enable a conclusion to be reached as to the use of motors on shipboard. If starting torque is essential and constant speed is unnecessary, the series motor is the best, an adjustable resistance being inserted as a protection on starting. For purposes calling for constant speed the shunt motor is best adapted, having a rheostat for use only in starting. In special cases the compound wound motor, possessing in a lesser degree the advantages of each of the others, may be best, but it is noticeable that its complexity is preventing its wide use in commercial practice."

As a rule the chief accident to motors is burning out the armature or field coils from overload in the circuit, for which there are two remedies:

1. A careful elimination of grounds at all times.
2. A circuit-breaking device, as a part of the starting rheostat, to break circuit at either *failure of the line voltage* or *overload*.

The matter of overload needs no other explanation than that the excessive current heats and fuses the wires.

Burning out from failure of the line voltage is the result of thoughtlessness or negligence and occurs in this way: The rheostat resistance is tapped at a series of places to points or blocks. In starting (Fig. 52) the rheostat lever, which is connected to one terminal of the supply circuit at *A*, is moved slowly

from point to point, or block to block, gradually decreasing the resistance in circuit, thus permitting more voltage to the armature of the motor, until the lever gets to the last block, *B*, when all resistance due to the rheostat is cut out and the current leads directly through the lever to the armature, giving it the total voltage of the main line.

There is usually a switch in the circuit. If a break in the main line occurs, thus shutting off the motor supply, the rheostat lever should be immediately placed on the block, *C*, where it was before starting; otherwise when the supply is renewed the motor suddenly receives the full voltage of the line before it has had an opportunity to start, receives an overload, as no back electromotive force is being generated, and the armature burns out.

It is this matter of back electromotive force which is so puzzling to the average attendant, but is readily understood from a brief explanation. Inasmuch as the armature of the motor revolves in a magnetic field, it becomes a dynamo to the extent of the number of its coils, the intensity of its field and the number of revolutions (see page 233), and of its own accord generates an electromotive force opposing that coming from the line; the current to be carried by the armature is by design based on the difference between the electromotive force generated by the motor, and that of the main line—a very small amount by the way—from which it can be easily understood why an armature burns out when suddenly subjected to the full electromotive force of the main line, and for the reason that its wires were never designed to carry such high currents.

Men will generally remember to open the switch, but in most cases of burnt-out armatures which have been investigated it has been found that the rheostat lever was left on the armature stop.

The burning out of the starting rheostat occurs almost invariably from attempts to use it as a speed regulator. The resistance wires are designed to be subjected only to heating effects for the short time necessary for starting, and it follows that if the lever is permitted to remain on any block but *A* or *C*, Fig. 52, the resistance wires will gradually overheat and finally burn out.

When speed regulation is desirable a controller of special design should be used.

The automatic starting rheostat shown in Figs. 52 and 53 ob-

viates both cases of burning out whether of armature or rheostat. There are a number of designs, but the principle involved is practically the same for all.

It consists, Fig. 54, of a hand lever, *H*, and spring lever, *S*, on a common pivot and working through a stiff spring, *K*. *A* is a double pole switch on the main line, *B* is the lead to the shunt field of the motor whose armature and its connections are diagrammatically represented at *C*.

As long as the automatic mechanism is not interfered with this rheostat can be relied on to protect the motor from all damage, under any conditions of practice, whether by skilled or unskilled hands. The following are the principal features:

1st. It automatically opens the circuit when the E. M. F.



FIG. 52.



FIG. 53.

(not current) of the supply circuit fails or falls greatly below the normal, required E. M. F.

Referring to Fig. 54, this is accomplished by the fact that, having no voltage, the lectro-magnet, *D*, cannot retain the armature of the spring lever, which immediately assumes the position of Fig. 53.

2d. It automatically opens the circuit when the current through the motor becomes excessively large.

This is accomplished by a second electro-magnet, *E*, whose armature is connected with a catch which holds the spring lever. When the overload passes, it causes the armature of *E* to be attracted, releasing the catch, and the lever assumes the position of Fig. 53.

For the same reason the circuit would be broken if the hand lever was moved too rapidly over the blocks, as excessive current would be caused by so doing.

3d. It is not affected under any conditions when the E. M. F. and current are kept within normal limits.

4th. The electro-magnet, *D*, will not retain the spring lever unless the hand lever is on the starting block, *C*, Fig. 52.

The arc (spark) formed by breaking automatically when running is generally taken up by carbon blocks that can be replaced at any time.

Compound motors have never come into general use for the reason that the armature reaction of a shunt motor will, in most cases, compensate for the falling off of speed due to the heat drop without the use of series windings.

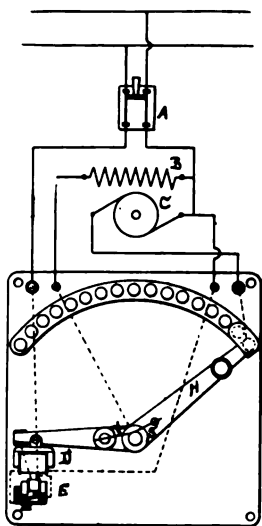


FIG. 54.

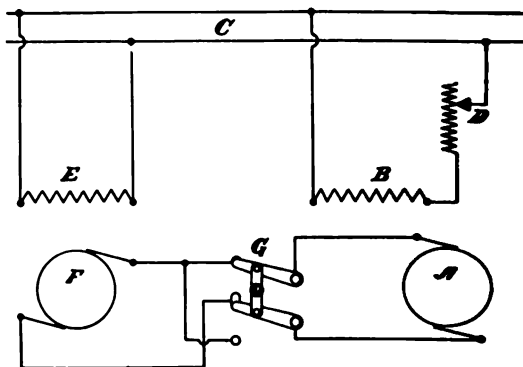


FIG. 55.

Motor use, commercially, has of late been much influenced by the extension of alternate current work, particularly of the two-phase and three-phase types, in which induction motors of simple construction, without commutator or brushes, have overshadowed the constant-potential, direct-current designs.

The high tension and heavy inductions of alternate-current work place it beyond the pale of ship use. Besides, it is difficult of regulation and uneconomical as compared with direct-current for other than long-distance transmission; the minimum of this long distance, as derived from European economics, appears to be greater than five miles.

The use of series (reversible) motors for guns and turrets has never proved successful from the inability to control the speed and regulate the train as compared with hydraulic, pneumatic or steam devices. A subsequent idea of using a positive motion (shunt) motor with a reversible clutch proved but a slight improvement. The problem has been solved in the extremely sensitive motions of the Brooklyn's turrets by separately exciting the fields of both dynamo and motor. The general principle is shown in the diagrammatic representation of Fig. 55. *A* is the dynamo armature, *B* its field, excited by current from the mains, *C*, which are fed by another dynamo. In order to flow through the field coils of *A* the current must pass through the controller, *D*, which is located in the turret and is as simple in its operation as that used by the motorman of a trolley car. The mains, *C*, feed also the field, *E*, of the turret motor, *F*, maintaining a constant potential. The armatures *A* and *F* are connected by direct wires through a reversing switch, *G*.

As the field of the motor, *F*, is constant, its speed will depend entirely on the voltage supplied to its armature by the dynamo, *A*, and the direction of rotation can be changed at will by the reversing switch, *G*.

As the number of circuits of the armature, *A*, are fixed by the design and its speed is constant for the adjustment of the governor of its engine, it follows that the electromotive force which it generates will be proportional to the intensity of its field. This intensity of field is regulated by the controller, which thus forms the key to the whole situation and can be located in the turret in the very best position for practical use.

In order to prevent the turret from turning too far a tripping toe is placed at the limit of its swing which automatically reverses the motor. No difficulty has been developed in the design, nor has there been any occasion for adjustment or repair since the war with Spain, to keep it up to the standard of its original test. Gross and fine train are accomplished without resort to any other expedient.

The dynamos which are installed for use with the motors are compound wound, and have an especial field connection for the change from motor to lighting use. This is not indicated in Fig. 55.

Interior Communications.—This part of the ship's installation is

more complained of, perhaps, than any other for the reason that it is more generally brought to notice and comes under the supervision of so many officers on the ships. The general complaint has been that the instruments are too delicate, require too many repairs, get out of order readily and are unreliable. The complaints have even extended to the point of characterizing them as laboratory instruments. Much of this is true, and efforts are being constantly made to minimize these faults as far as possible on the lines of simplicity in construction, continuity of service and certainty of action. It is to this field that much inventive talent, especially in the service, has been directed, but of the many designs of instruments which have been submitted fully 80 per cent. do not answer service requirements. Of these the large majority have been constructed on the step-by-step principle. A step-by-step instrument is one in which the indications are made successively and which usually depends for its actions upon a train of wheels, or at least upon a combination of cog gearing, which accomplishes the indications required. They are practically inadmissible for the reason that the cogs soon wear in service or break out, and once a tooth slips or is missing the instrument becomes unreliable thereafter. This sort of wear is very much hastened in instruments which require that the electric current shall be kept on, and, in general, it may be said that it is desirable in any instrument that the current should be broken after each indication, excepting in those in which the indications are made by lamps.

A notable example of the step-by-step instruments were the Elliott instruments placed in the Maine. The commanding officer requested that they be taken out of the ship as they were of no practical utility and only occupied needed room on the bridge. These instruments have been installed in trans-Atlantic steamers and have given satisfaction, but require the continued attention of experts.

Engine Telegraph.

Fiske Type.—The instrument embodies, as do all of Lieut. Fiske's inventions, a large number of desirable features for ship's use, but it was found on two ships after long trial to be unreliable, and that even after repairs were made by the manufacturer's experts, it was impracticable to so adjust the instrument that the

indications on the bridge and in the engine-room were the same. If the differences in indications had been equal over the range of the scale there would have been less objection; the differences in indication being known they could be easily applied by the operator or reader, but with variable differences for different readings the intended order became too uncertain.

From a total of six ships in which the instruments have been installed two have reported favorably and four have requested adjustment or repairs. In the two cases above mentioned an old design was installed.

The primary fault is lack of water-tightness in the transmitter where contacts and connections are found to be corroded and oxydized.

A second fault appears to be purely electrical. It is not altogether clear what the fault is, but since the original instrument has been constructed the temperature corrector has been added to the device, showing that errors of resistance affected the readings and, in late repairs, it has been found that many faults have been introduced by the method of wiring, the introduction of small resistances after compensation, and in loose or imperfect contacts.

It is believed that this instrument can be made to operate successfully by perfecting the contacts and so introducing the resistances that there will be no variable. Its principles are good and sound, and it would seem that a change in the device would much relieve its present defects.*

Painter-Morrison Type.—But one set has ever been installed in the service and is now on board the Nashville for trial. The instrument has an escapement somewhat on the stock-ticker principle and comes under the head of step-by-step instruments, though especial attention has been paid to overcoming the usual objections.

Leopold Type.—This combination introduces a visual manual by the use of lamps in addition to a bell signal calling attention. It has never been tried thus far and no information has been obtainable as to its practical working.

* Illustrations of Lieut. Fiske's instruments are not reproduced in this article for the reason that they are shown in detail in his publications on the subject, and to them the reader is referred.

Revolution and Direction Indicators.

Fiske Type.—This introduces the principle of alternating current in instrument devices and is operated by the action of a soft iron inductor (placed on the shaft) revolving in front of the poles of an electro-magnet and connected with indicators which are constructed on the principle of alternating-current voltmeters. The voltmeters soon fail to indicate. In one case which has been brought to notice there has been no practical use obtained from this instrument since its first installation except on original test; all efforts to repair and put it in good working order have proved futile. In another case the magnets were placed so low down in the shaft alley as to bring it in frequent contact with



FIG. 56.

bilge water, causing burning out. The magnets were afterwards shifted from their position, but the indications have been very erratic and unreliable.

A particularly cumbersome feature of the design is that there must be a separate collar and inductor on the engine shaft for every indicator installed. This could be avoided, perhaps, by the use of separate magnets, installed about the shaft, each connected to its own indicator. A difficulty with the galvanometer (indicator) arises from the leaking of the liquid with which it must be filled. Available liquids for the purpose seem to be few in number and not readily obtained.

The direction indicator of Lieut. Fiske's device has a collar for the magnet which revolves with the shaft

which current is led to an indicator self-contained with that for the revolutions. As the pointer merely deflects at each revolution there is no difficulty in having the instrument work properly at all times and, by timing the deflections, the revolutions of the engine can be accurately counted. It is, however, inferior for the purpose to Cory's design, inasmuch as the pointer must be watched while timing, while in the Cory type the deflections are made audible.

Cory Type.—The objection to the Cory type of instrument is that it is not direct reading. Its advantages are that it is simple in construction and does not readily get out of order. The wiring is quite simple and the deflections of the pointer indicate without and difficulty whether the engine is going ahead or astern. In making these deflections a clicking noise is made from which the revolutions can be timed by sound as well as by watching the deflections of the pointer. This particular style of indication is known as the "tick-tack."

Fig. 56 shows the instrument as mounted on the bridge, and Fig. 57 shows diagrammatically the connections and general construction, as follows:

A cogged eccentric, *A*, is attached to the shaft and revolves with it. The cogged wheel, *B*, gears into this eccentric and has an upright, *C*, carrying a cross arm, *D*, which makes contact with springs at *E* and *F*; this combination can swing about a center at *G*, and in each revolution the wheel, *B*, is dragged enough in the direction of rotation of the shaft to make contact at *E* and *F*, accordingly as the engine is going ahead or astern, and always on the same spring for the same direction of revolution. At each of the springs *E* and *F* are connections to two electro-magnets in the indicator, but three wires being necessary as one wire answers as a common return for both. An armature connected to the pointer of the dial is attracted by the magnet, which is energized and is arranged with a sounder to give an audible "tick" at each attraction (each revolution). The current is tapped off a lighting circuit through a line rheostat. It is obvious that the only requirement of operation is that there should be sufficient current in the line to energize the magnets of the indicator, and that it is independent of variable resistances in connections, provided that the requisite energy is supplied. Any number of indicators can be connected in by simply paralleling from the leads from the transmitter at the shaft.

This instrument gives very little trouble; when troubles do occur they are generally from erosion or burning out of the pieces of wire at the contacts of the transmitter, which are very easily adjusted.

Electro-dynamic Type.—This instrument is practically a small dynamo which is geared or belted to the shaft, and which has its

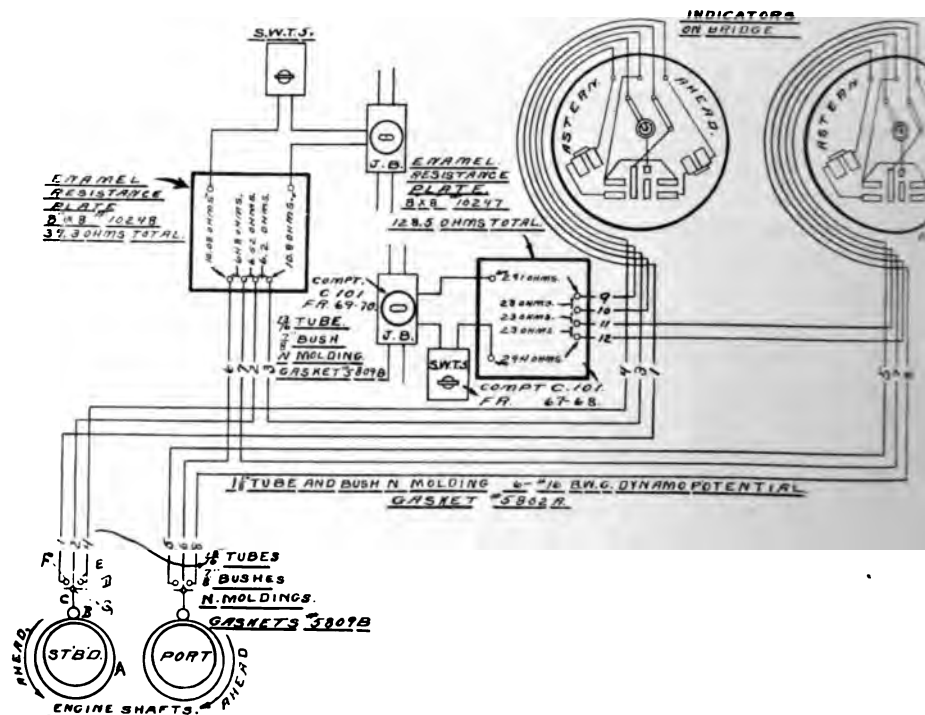


FIG. 57.

field separately excited from a direct lead to the dynamo circuit. It is evident from this arrangement, since the fields are separately excited, that the voltage produced by the dynamo will depend entirely upon the number of revolutions and the indicators need only be small voltmeters, something on the order of our ordinary portable type. An especial design is used in the actual device. The dynamo can be mounted anywhere conveniently for its shaft connection, can be entirely encased for its

protection and needs only the attention of trimming or shifting the brushes.

The indicator is simply a voltmeter reading both ways from a central zero (similar to the Weston ground detector, Fig. 27), the voltmeter being marked on one side for *ahead* and on the other side for *astern*, the direction of the pointer indicating the direction of revolution of the shaft and calibrated to show revolutions instead of volts. Owing to the fact that voltmeter indications are not reliable at small indications the reading will probably not be correct below twenty revolutions; but as, in ordinary ship practice, we merely wish to know, at such low speeds, the direction in which the shaft is turning and are not particularly concerned as to the number of revolutions that the propeller is making, this objection is really a small one. An instrument of this type was installed in the Brooklyn and has given general satisfaction.

Helm Telegraph.

Fiske Type.—As this instrument consists merely of a transmitter and voltmeter-indicators, for which the current is tapped off a lighting circuit, the transmitter being a resistance in the line, there is very little to get out of order, provided contacts and connections are looked after. But one instance of trouble with the helm telegraph has been brought to notice, and that in a ship where the transmitters not in use were not zeroed as called for by the directions; the transmitter was burned out. A cut-out switch for each transmitter is now installed.

Helm Angle Indicators.

Fiske Type.—The inventor points out that 90 per cent. of all troubles with this instrument will be found in the contact. The contact of the arc is found to become variable and unreliable, thus defeating the utility of the instrument. This is occasioned by wear, vibration, moisture in the damp compartments in which it has to be placed and the friction of the plunger on the wire itself. As in all Fiske indicators, the galvanometers are too sensitive; they are not sufficiently water-tight, inviting the rust and corrosion which are such frequent sources of repair; their adjustments are too delicate and require too much care and attention for the character of the available personnel. Indica-

tors of new designs more in consonance with required practice will remedy many of the complaints made against them. It becomes a particular matter in connection with the helm angle indicator for the reason that the action depends entirely upon the difference in voltage in the two sections of the contact wire, and it must be evident that a very sensitive indicator will take up irregularities of contact and become spasmodic and jerky.

The principles upon which this instrument is founded are sound, but from the nature of the use and the locality in which it must be installed it cannot be recommended for ship use.

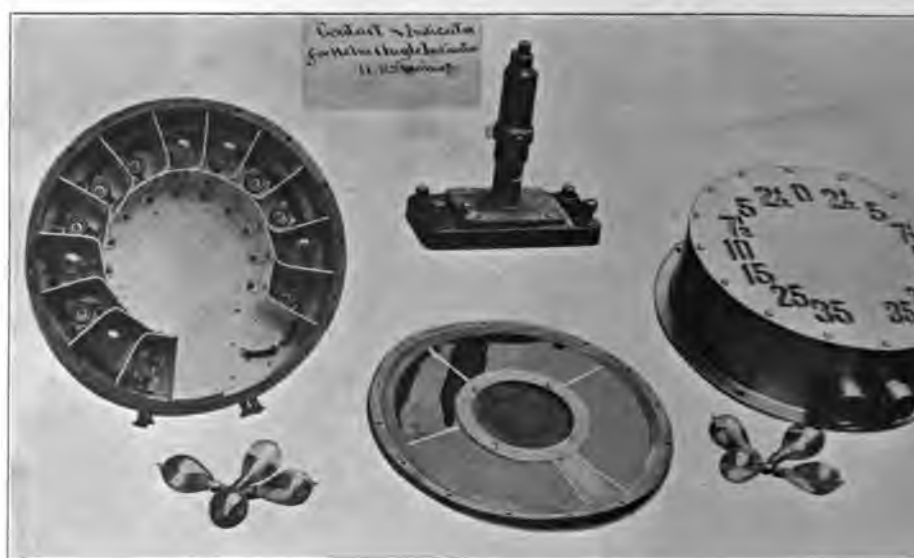


FIG. 58.

Painter-Morrison Type.—This instrument is a modification of that spoken of under engine telegraphs, the motion being communicated to the transmitter by a chain and wheel attached to the rudder head. A bicycle sprocket and chain are usually used. The instrument is on trial in the Nashville, but thus far no complete report has been made on its performance.

Lamp Type.—This is shown in Fig. 58 ready for mounting on a pedestal or bulkhead. Fig. 59 shows the connections with the locations for the action cut-outs, and Fig. 60 shows the arcs on

which contact is made from the plunger carrying the wires. It consists merely of fifteen lamps of 5 c. p. at 80 volts placed in little compartments and shining through a plate of green glass on one side and a plate of red glass on the other side with a piece of white ground glass for the zero indication. The wires are led as in an annunciator, one wire to each lamp with a common return. Contact is made on the arc (to which fifteen wires are

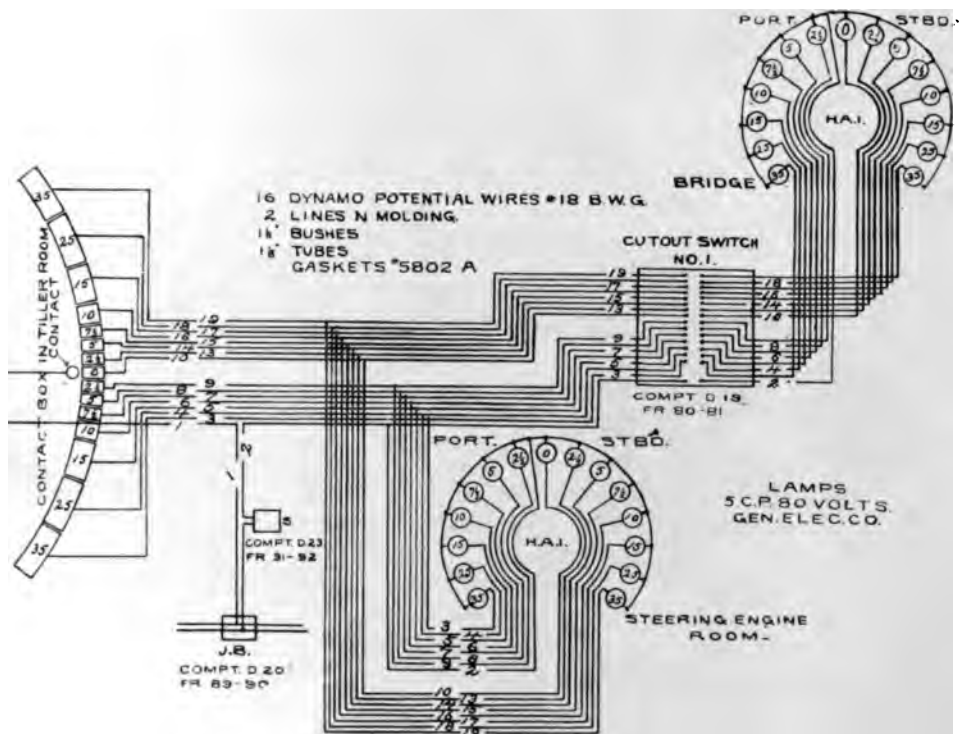


FIG. 59.

connected) by a plunger attached either to the tiller or to a monkey tiller or a yoke secured to the rudder head. The instrument can be recommended as being thoroughly reliable in its operation, has been tested for long intervals and required no repair.

The wiring is done through interior communication cables directly from the points of contact or between connection boxes. It has been urged against this instrument that the indications are not in sufficient number for tactical use, but the different

degrees of helm which are indicated, as shown in Fig. 58, are all that have been found necessary in tactical evolutions and are thought to be sufficient. It has also been objected that the indication is too dim in daylight to be seen at required distances; in all cases which have come under observation the objection does not seem to be well founded. It can be highly recommended as simple and constant in operation which, at least, are two very vital features on interior communication lines.

As a resumé of the difficulties with instruments for the uses mentioned it may be said that present practice indicates the doing away with types depending upon changes of voltage or resistance and substituting devices which are simpler in their care and connections. These, as now proposed, are:



FIG. 60.—CONTACT ARC FOR LAMP HELM ANGLE INDICATOR, U. S. S. MAINE.

Engine Telegraph.—Establishment of prescribed speed by verbal order or mechanical telegraph, the variation from prescribed speed to be signaled as so many turns (up to five usually) *faster or slower*. The instrument for this signal is modified from the design of the lamp helm indicator, the transmitter being similar to that of the mechanical telegraph; attention is called by a bell.

Steering Telegraph.—This is similar to that for the engine telegraph, the indicator being marked for angles of helm and one or two especial orders, such as "steady," etc.

Helm Angle Indicator.—The lamp instrument before described.

Battle Order.—Transmitter and indicator are of the lamp type and on the general principle of the lamp helm angle indicator.

Range Indicators.—Are similar to those for the battle order.

Each type necessarily requires its own especial construction.

though all are the same in general principle. The apparent disadvantages of lamp types is their bulk.

There is an objection to the engine telegraph in that it requires the use of the mechanical as well. As long as the leads for mechanical telegraphs are short, they work well; but when complicated, as in large ships, or where the leads are long and require to make a number of turns, they must be looked after continually.

General Alarm.—Difficulties have been reported with the types installed:

First, from giving alarms under ordinary shocks and vibrations in the ship, especially at gun practice. This feature has been overcome to a marked extent by the introduction of a catch similar to that used in the construction of annunciators.

Second, in failure of operation, which can be mostly attributed to lack of voltage in the line.

Alarm-gongs, as a rule, will not operate under less than 15 volts, and unless the batteries are in good condition and up to voltage this difficulty will generally appear. As a rule, the general alarm system should be placed entirely on the transformer with a battery connection as a preventer.

There has been great difficulty in getting a satisfactory gong. The electrical type is better and more certain in operation than the electro-mechanical types, but owing to the large amount of repair which has been called for in this system, the electro-mechanical gong has practically been adopted. The gong should be 12-inch single-stroke. All double-stroke gongs soon get out of order and require replacing. There is an important point in the installation of alarm gongs which has been much lost sight of, and that is that they should not be operated by an ordinary push button. Alarms have frequently been sent in when cleaning the push buttons, especially in chart houses, and in many instances it has been found necessary to entirely insulate the spring from the contact by introducing a wedge of hard rubber. The easy way out of this difficulty is to entirely encase any arrangement for ringing alarms which can be accidentally touched or handled by the men. The uncovered push button is inadmissible in any case. Failure to operate can frequently be remedied by adjusting the tension of the springs.

Batteries and Transformers.—The batteries furnished are made

up of the Gonda or Sampson modifications of the Leclanche cell. This type of cell has a high electromotive force (about 1.43 volts) and low internal resistance (about $\frac{1}{4}$ ohm), giving it the capacity of sending a strong current comparatively.

It has the great disadvantage that it polarizes very rapidly on closed circuit and the voltage soon drops below required working limits; it is only available, therefore, for uses requiring a strong current for a brief time.

This fact affords a solution to the mysterious failure of alarm gongs and bell calls which occurs from time to time on board ships; it is generally due to an insidious polarization of the batteries by grounds which complete and close the circuit through the cells. It is not that the batteries have given out, but that they are polarized and the condition will be evidenced by a deposit of bubbles (hydrogen) on the carbon elements; if the end battery connections are broken for a couple of hours the cells will recover their normal voltage.

The indication that the battery has run down and needs recharging with sal ammoniac is a milky color of the cell fluid. The jars should always be kept full and the liquid clear. Dipping the zincs in mercury will prolong their life.

The troublesome feature of polarization of batteries by grounds is the great argument in favor of transformers, for grounds have but slight influence on the voltage generated by the transformer and appear only as overload. The transformer is intended for general use on the lines, the batteries to be kept in reserve for emergencies.

The voltages commonly required are about 6, 12 and 20, and can be obtained from any transformer by fitting two extra brushes; it will be found to produce no sparking. As frequently installed, a double-throw, double-pole switch is provided by which either the battery or transformer can be switched in as desired. There is a disadvantage in this arrangement in that lines for small bells require only 6 or 12 volts usually and the higher voltage of the transformer—necessary for the general alarm system—soon burns out the vibratory contacts.

It is better to fit separate brushes for tapping off the required voltages and connect the brush leads to the individual lines through a battery transfer switch, as shown in Fig. 61, which can be expanded for any number of circuits desired. This switch has

the distinct advantage of providing a point where the circuits can be readily tested out in detail and where grounds and faults may be localized.

The slopping out of the liquid in batteries on ships which have much motion at sea points out the desirability of the use of dry cells. There are several good forms in the market, of which the non-polarizing, Fortosec and Mesco can be recommended; the E. M. F. is somewhat less than that of the Leclanche. Dry cells do not recover well when polarized and unless, therefore, a transformer is at hand for general use, a number must be kept



FIG. 61.

in stock to replace those that fail. If care is taken to keep the circuits free of grounds, dry cells are an advantage; they are practically imperative for use in torpedo-boats and destroyers.

Action Cut-outs.—These are now placed on all lines of communications not protected by armor, in order that the unprotected sections may be entirely cut out in action and prevent grounds or short circuits on the lines in use. The device consists of a contact maker operated by a thumb-nut which pushes up the contact springs. The switch is a carbon block of rectangular section enclosed in a brass frame and connected with the thumb-nut. It is merely necessary to move the nut a quarter of a turn to throw the contacts in and out.

Annunciators.—The principal repair and difficulty with annunciators has been in the failure of operation of the drops. In many cases the troubles arise from a collection of dirt and cockroaches about the electro-magnets. Two have been sent up for repair that operated perfectly when brushed out with an ordinary whisk broom. No difficulty has been found with the new types of water-tight devices. Most troubles with annunciators can be avoided by keeping the case locked and occasionally seeing to it that there is no collection of dirt between the electro-magnets.

Cases occur where the failure to operate is due to a too stiff or too weak spring; the remedy is, obviously, to correct the tension.

Testing Out.—The ordinary test devolving on the force is that for insulation resistance, and should be made on all dynamos and circuits every week. For this purpose the simple voltmeter

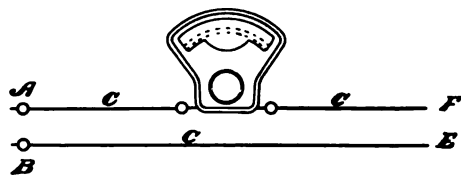


FIG. 62.

test, so little in use, is amply sufficient. To make use of the test the ordinary portable voltmeter is used and connected in, as shown in Fig. 62. *A* and *B* are any two points of a switchboard or lighting circuit; *V* is the voltmeter and *C* the leading wires. If the ends of the leading wires, *E* and *F*, are touched together we will get a deflection in *V*, which we will call *D*. If *E* (or *F*) is touched to one leg of a circuit and *F* (or *E*) is connected to ground we will obtain another deflection, *d*. The insulation resistance is then:

$$\text{Ins. Res.} = R \left(\frac{D}{d} - 1 \right),$$

in which *R* is the resistance of the voltmeter *V*. Evidently if *D* = *d*, the insulation resistance is zero and the circuit has a dead ground.

This method requires but little time as compared with that of the Testing Set (Wheatstone's bridge), and while not

rate as the latter, the results are sufficiently so for all practical purposes.

A magneto will ring if there is a dead ground but will not indicate a low insulation; the voltmeter test is therefore preferable, as it shows the approximate insulation resistance in each circuit. Each circuit, whether of dynamo or main lines, should show an insulation resistance, individually, of at least one megohm (1,000,000 ohms), but it must be remembered that dirt, dust and moisture can make it quite possible for a circuit to show a dead ground when the actual insulation resistance is above five megohms. This occurs most frequently when testing dynamo circuits.

Insulation resistance is lowest when the insulation is hot; a current should, therefore, be allowed to flow through a circuit for awhile before testing. The insulation resistance of a dynamo should always be taken after it has been running in order that the circuits may dry out; the shaft end of the commutator should be thoroughly dried with a cotton rag and all dust and dirt removed from the armature and field coils. Moisture and dirt at the joints of the field frame and bed plate will occasion a grounding of the frame.

Conclusion.—The panacea for the great majority of the difficulties with our electric installations on board ship resides in the possession of a competent dynamo force. It is, perhaps, impracticable that the whole force can have the necessary intelligence, and it may be desirable that a part should be under instruction, especially a number detailed from the apprentice class; but there should be at least a competent head whose duty it would be, as a "head dynamo man," to have charge of the entire installation, to direct subordinates in its management and repair and to instruct them in its mechanical and electrical details.

It is apparent that the ships are not sufficiently self-supporting and that adjustments and repairs which should be well within the capacity of the force are held over for that future day when the ship can arrive at a navy yard, and the work be required from the yard department. Meanwhile, "the stitch in time," so vital in engine and electrical faults, tending as they do to become rapidly worse, is not taken, and the cost and magnitude of repair has much increased. On the other hand, in many instances, the equities of the case rest with the ship; the majority of men avail-

able have had no experience with mechanical or electrical details of the installations; those who obtain experience in navy yards usually prefer to remain in civil employment, if good men, by reason of better pay; transfers and discharges prevent the establishment of confidence in those who are made available and the best men obtain warrants or disappear to the navy yard forces or to employment in commercial life.

In order to secure to each ship the competent man to control and look out for our installations, increasing constantly in scope and expense, and to vest him with the necessary authority, he should be given a warrant; he should be a good engineer familiar with the design, operation and repair of short-stroke engines; he should have an electrical knowledge which will enable him to cope with all principles applicable to the installation; he should be conversant with the mechanical details of wiring and accessories.

The incentives of warrant and advanced pay will attract good men to the position; as it is, some of our best men are leaving the service.

APPENDIX A.

INSTRUCTIONS REGARDING ELECTRICAL PLANTS.

At the time the ship goes into commission the entire plant is supposed to have been previously tested, with everything in place on board and accepted. Previous to the test for acceptance, the dynamo and engine are supposed to have been inspected at the factories, and the wiring inspected as the work of installation progressed. A general graphic description of the plant will be found in the "Record of Electrical Appliances" which is supplied to the vessel. Nothing remains then but to keep the plant in a thoroughly good and efficient condition during the cruise. To this end the following rules and suggestions for the care and management of the plant will be carried out:

DAILY TEST.

The ground detector will be kept in use at all times whenever the plant is in operation. This will at once indicate the presence of a leak to earth of any importance. The branch circuit in which the fault occurs must at once be located and the use of that circuit discontinued until it is again in order. It must be strictly borne in mind that to make this detector of any use, the faults must be removed as soon as they appear, or the circuit in which it occurs cut out, for it will not indicate a second fault until the plant is cleared of the first. On the other hand, with proper care, the ground detector is invaluable. In addition to the above, whenever any of the machines are shut down, advantage must be taken of this opportunity to test them for leaks between the different coils, the coils and the frame, and other parts of the machine. If the fault that occurs is of slight importance, it may at times be advisable, after locating it, to allow it to remain until it becomes worse, measuring its resistance, however, and noting its progress.

Used with the new standard switch-board, the branch circuit in which any fault occurs will at once be determined. Each section should be tested at least once daily, and this should be done by throwing off all the sections except the one to be tested. This should preferably be done at such times that the throwing off the lights will not interfere materially with the routine of the ship.

WEEKLY TEST OF SEARCH-LIGHTS.

These will be operated at least once a week at night to see that everything about them is in good working order and the fact recorded in the journal. At such times care will be taken to have the ground detector connected.

Projectors that are electrically controlled will be tested both by hand and by the electric control. All projectors will be kept at all times ready

for instant use, requiring only the throwing on the switch in the dynamo room.

QUARTERLY TEST OF PLANT.

Once a quarter measurements must be made of the insulation resistance of the entire plant connected up together, also that of each dynamo and of each of the section circuits leading from the switch-board. At such times advantage should be taken of wet weather if possible. At least once a quarter the entire plant must be operated for a long enough time to see that everything is in working order. At this time everything must be connected up; that is, all lamps, search-lights, motors, etc., within the safe limit of output of the machines.

QUARTERLY REPORTS.

These shall contain the results of the quarterly and any special tests that may have been made, as well as the expenditure of all articles used in operating the plant, and its condition. The record should be kept in such a state that the cost of operating the plant can at any time be figured. The behavior and condition of engines, dynamos, lamps, and in fact the entire plant, must be noted, as well as the cause of every fault that occurs. In addition to the above, special reports must be made when necessary for the efficient condition of the plant. The blanks for lamp reports made by the officer in charge must be made and retained on board.

CARE AND MANAGEMENT OF PLANT.

Too much care cannot be exercised to see that the entire plant is kept in order. Constant watchfulness on the part of the attendant and observation on the part of the officer in charge to see that the attendants are kept up to their work is absolutely necessary. One fault of itself is frequently of small importance, but when another is allowed to appear in addition, then serious trouble is liable to occur. Too much care cannot be given to the engine. Keep all working parts clean and lubricated. Inspect frequently for any undue wear or lost motion, and keep the drains and other appendages in order. Be economical in the use of oil and other stores. Notice the cause of any unusual noise about the engines. In long leads of pipe, with many bends and branches usually found on shipboard, more or less condensation takes place; this, together with the fact that steam aboard ship is more or less wet, requires that every precaution should be taken to prevent water getting into the cylinders, which in high-speed engines will do much damage in a very short time. The tachometer will not ordinarily be used even if supplied; the shaft portable speed indicator will ordinarily answer every purpose. *Be particularly careful on starting to run slow until warmed up and water out of cylinders.*

Every engine belonging to the electric plant, boat outfit, etc., should be turned over by hand every day when not in use, and the fact noted in dynamo journal.

In starting engine, the dynamo brushes should be raised. After engine is running smoothly see that brush holders have not been shifted from

marked positions, and see that main switch is open. Lower brushes, and if dynamo has switch in shunt field, close it. Adjust brushes until there is no sparking, noting voltage at same time; then close main switch, noting that all section switches are open. Throw on load gradually, attend brushes at each change of load and shift if necessary.

In shutting down dynamo follow the reverse of the above. In cases when it is known that certain lights will be wanted immediately after starting up, a reasonable load will be put on as soon as the engine is running smoothly and before commencing to speed up, in order that the lamps may attain their candle power gradually and their life thereby increased materially.

As regards the dynamo, the commutator and brushes are what require the most attention; that is, the brushes to be kept trimmed and at the neutral points, and the commutator kept smooth and free from uneven wear. All connections kept tight and clean; copper dust, oil, and moisture kept off the machine and the machine properly lubricated. The pilot lamp must always be kept in circuit in case the main safety fuses go. Be on the watch for any unusual heating of the field magnets or any softening of the insulation. In throwing dynamos in parallel care will be taken to see that each machine is poled right and kept on open circuit until the nominal potential is reached before being thrown into circuit. The operation of throwing dynamos in parallel with the naval standard switch-board is as follows: Each dynamo must first be tested separately. It is brought to the proper potential of 80 volts on light load by adjusting the shunt field rheostat. Full load is then thrown on and the voltage should remain the same. If not, it should be adjusted to give the proper voltage by the shunt to the series field. This adjustment should be once made and occasionally verified; too much care cannot be given to it, and once adjusted should not be tampered with. With loads on each dynamo practically the same, and the difference of their potentials less than one volt, the multiple switch may safely be closed and the dynamos will work together. Any inequality of load between them may then be rectified by the shunt field rheostats. The polarity of the dynamos will be shown by these measurements, and, as has been said, should be the same. When one dynamo is to be thrown in parallel with another actually working it may be advisable to divide the load about equally between them and repeating the observations as to potential before throwing them in parallel. All important instruments must be standardized at least once a quarter, if practicable, and the fact noted in the quarterly report.

When not in use the engines and dynamos must be covered.

With the new standard switch-board the following precautions are necessary for its safe and successful working:

1st. No metal, such as screw-drivers, monkey-wrenches or other tools or watch chains, should be allowed near the front of the board. Any neglect of this kind may cause dead short circuits.

2d. Putting more than one plug switch on any one section is positively forbidden, as the use of two might put dynamos in parallel without any equalizing bar.

3d. If any section is not wired up, it is advisable to remove its plug switch entirely.

4th. In throwing a section in circuit it is advisable to first place the plug switch in proper position for putting the section on the dynamo desired, and then close the switch on the common bus bar. In cutting out a section first open the common bus-bar switch and then the plug switch. In changing a section from one dynamo to another, it is best to first break the circuit with the common switch, then throw the plug switch over into proper position and close the common switch. The plug switches are not intended for throw-over switches.

5th. When any section is wired up, but not in circuit, its common switch should be open, and its plug switch open and locked.

6th. When the dynamos are operating singly the multiple switches should be open and the spring clips covered by hard-rubber covers. These covers to be removed before attempting to connect in parallel.

The record book supplied the ship with outfit contains a general graphic description of the plant. The changes will be noted in this book from time to time, so that the thread can be easily picked up. No change will ever be made in the original plan of wiring or extra outlets run without at once notifying the Bureau.

In the dynamo journal the remarks are to be made as complete as possible. The columns of the journal are to be kept as at present, except that the revolutions will not be recorded as long as the plant is in good working condition. The load for each dynamo will be recorded in its proper column at the end of each hour, unless there is an unusual load on at that time, when the average for the hour will be recorded.

All faults or bad working of the plant in any respect must be noted in the journal.

As regards the circuits, careful daily inspection of connections is necessary to keep them clean and tight; also look for deterioration of the insulation of the wires. With new lamps, those requiring the highest voltage to give their rated candle power must be placed as near the dynamo as possible, those requiring lowest voltage farthest off. The lamps farthest from the dynamo must after a time be shifted near the dynamo in order that they may continue to give their normal candle power.

All lights and fixtures in general use should be inspected and cleaned every day. In cleaning fixtures, especially plated ones, scouring or hard rubbing will not be permitted. They should be wiped off with a cloth or chamois skin.

As previously mentioned, the commutator must be kept free from uneven wear. The necessary evil of all continuous current machines is the commutator. Not only must the brushes be trimmed and placed so as to prevent sparking, but they must also have their position changed from time to time in the direction of the length of the armature, so that the entire surface of the commutator will have the same amount of wear.

During target practice the search-light projectors should be trained and clamped so that they will be parallel to the line of fire, if practicable, the door opened in order to save the lenses from the destructive effect of concussion.

The use of files, sand, emery paper, etc., on commutators is prohibited, except in extreme cases, when it will be fully noted in the journal, and then only by the direction and under the personal observation of the officer in charge of the plant. Under no circumstances whatever will these be used unless the brushes are lifted from the commutator.

When a record is being kept of the life of a number of lamps, the fact must be noted in the dynamo journal in such a manner that it will be brought to the notice of a new officer taking charge of the plant.

The safety fuse will not be replaced with the current on, unless it is absolutely necessary. Even then it must be done by skilled hands and with extreme caution, as the slipping of a screw-driver is liable, in such cases, to put the entire part of the ship supplied by that section in darkness.

With the new junction boxes the fuses may readily be replaced without the turning off of the current.

The dynamo journal will be submitted upon the last day of every month for the approval of the commanding officer, and when filled, forwarded by the first favorable opportunity to the Bureau. Unbound journal sheets are furnished for use in dynamo-room. Each sheet is intended to last two days.

The original invoice, when a vessel is commissioned, will show the electric plant as installed ready for operation, the different articles being enumerated. Spare articles and stores should be separated from the installation. Care should be exercised in making quarterly returns that all articles on board connected with the plant are enumerated whether found in the installation, among the spare articles, or in the stores.

APPENDIX B.

SPECIFICATIONS.

GENERATING SETS.

Sets.

1. Each set shall consist of an engine and a generator secured on a common bed-plate and connected by a solid flanged approved coupling through bolted and keyed.
2. The sets as a whole shall be as compact and light as is consistent with a due regard to strength, durability and efficiency.
3. Their gross weight must not exceed one-third ($\frac{1}{3}$) of a pound per watt of their rated capacity.
4. All parts of the sets must be accessible for examination, adjustment and repair.
5. Suitable arrangements must be provided for effectively lubricating all parts of the sets which require lubrication and for conveniently collecting and recovering all surplus oil.*

* This specification has been recently modified to specify forced lubrication.

6. Oil-guards shall be fitted wherever necessary to prevent oil from being thrown about by the machinery when in motion.

7. They must operate practically without noise, be thoroughly balanced, and run true, and be capable of being run for long periods under full load without undue heating or wear. All nuts liable to work loose to be lock-nuts; all lock-nuts and pins to be secured against working off by a suitable locking device, which will act with certainty to prevent the bolts or parts which they secure from working loose from the vibration or movement of the mechanism.

8. The driving-shafts must be fitted with thrust-collars or other suitable device which will prevent a movement of the shaft in the direction of its length when the set is subjected to the rolling motion of a ship at sea.

9. All spare parts must be made of standard sizes, so that each will fit any set of the size and type for which it is made, and the fact that they do fit must be demonstrated by actual trial when generating sets are tested for acceptance.

10. Contractors must furnish a complete set of tracings of working drawings for each type of generating set supplied, such tracings to be a part of the contract.

11. Any defect clearly due to defective material or workmanship which may be developed prior to the completion of the first year of service, to be made good by and at the expense of the contractors.

12. During tests for acceptance the sets are to be run with a quality of oil similar to that used on shipboard which has been through the filter after having been previously used.

Engines.

13. The engines must be vertical, strongly built, of the very best materials, thoroughly balanced, and of high efficiency and economy. Their efficiency and economy to be determined by means of suitable tests. Unless expressly specified to the contrary, engines must be designed to work most economically with a steam pressure at the engines of 100 pounds per square inch, if compound, and with a steam pressure of 80 pounds per square inch, if simple; the vacuum to be maintained at not less than 25 inches; but they must be capable of working with pressures of twenty (20) pounds above and below the pressures prescribed for most economical operation.

14. The cylinders must be of hard cast iron; the crossheads, connecting rods, shafts, piston and valve rods, and all nuts, bolts, etc., of the best forged steel.

15. Their design must be such that all parts subject to wear shall be accessible for adjustment and repair, and especially those parts which by reason of wear are liable to affect the alignment of the engine.

16. They must be able to bear without injury the throwing on or off of the entire load by quickly making or breaking the external circuit of the generator.

17. Cylinders shall be fitted with relief-valves, arranged to work automatically, in addition to the usual drain-cocks.

18. The engines must be fitted with automatic governors, which shall

be simple in construction and be made of the most durable materials. The governors must control the speed of the engine automatically, the throttle-valve being wide open within the following limits: A variation of not more than two and one-half ($2\frac{1}{2}$) per cent. in the number of revolutions will be allowed on any change of load from the total rated output of the generator to twenty (20) per cent. of the same, when the engine is running with a constant steam pressure, which is to be that required for its most economical operation, as prescribed in paragraph 13. A variation of not more than three and one-half ($3\frac{1}{2}$) per cent. will be allowed when the steam pressure is varied between allowed limits, under no load or full load. An extreme variation of not more than five (5) per cent. will be allowed when both steam pressure and load are changed between limits of pressure allowed and full and no load.

19. The cylinders and valve-chests must be covered with a suitable non-conducting material and cased with an approved covering. The cylinders must be fitted with indicator-motions.

20. If the engines have more than one cylinder, the work done in each cylinder must be practically equal, when the engines are working at the normal steam pressure and under full load.

21. It is very desirable that the engines shall be capable of continuous running without the use of lubricants in steam spaces.

Generators.

22. The generators must be of the direct-current compound-wound multi-polar type, and be so designed that their external magnetic fields, at full load, shall be inappreciable at a distance of fifteen (15) feet, measured in all directions in a space free from magnetic material; the effect to be determined with a horizontal-force instrument.

23. The field-frame must be divided in a horizontal plane passing through the center of the shaft, the two parts being properly secured with bolts in order that the upper part, with its pole-pieces and coils, can be separately removed.

24. The standard voltage for all generators shall be 80 volts, measured at the terminals.

25. The compounding of each generator must be such that at the designed speed of its engine the voltage shall at no point of the external characteristic curve vary more than one and one-half ($1\frac{1}{2}$) volts from 80 volts over the whole range, from no load to full load, both up and down, no change being made in the field rheostat, and the brushes being at the neutral points.

26. The generators shall be capable of operating in parallel.

27. The armature must be thoroughly ventilated, well balanced, and run true, and must be so secured on its shaft that, while admitting of being readily removed when desired, it shall not slip or work loose from any cause while in operation. Its shaft must have large bearing surfaces, which must be efficiently lubricated by self-oiling bearings. A satisfactory arrangement must be made in its bearings to prevent oil from running along the shaft or from being spilled. There shall be no extra pressure upon its bearings due to the magnetic pull of the pole pieces on the armature.

28. The commutator segments must be of hard-drawn or drop-forged copper, insulated with mica, and have ample thickness to withstand wear for a long period. It must have ample brush-working surface and its radiating surface must be sufficient to prevent it from heating to such an extent as to materially affect the temperature of the armature winding through conduction under any load within the capacity of the generator.

29. There shall be no sparking whatever at the brushes when the generator is in operation with a constant load, nor shall there be any detrimental sparking with a change of one-half ($\frac{1}{2}$) load, the brushes not being moved.

30. The following are the maximum limits of temperature permissible in the several parts of the generators, after the full-rated output of the generator has been continuously produced for a period of at least four (4) hours: (a) Temperature of field and armature windings above the temperature of surrounding air 60° F. (b) Temperature of commutator above the temperature of the surrounding air 72° F. The temperature of the surrounding air to be determined by means of a thermometer hung three feet from the generator on the side away from the engine and on a line with the shaft; its indication to be read after the heat-run at the moment of stopping. The temperature of the armature and of the field-coils to be calculated from their electrical resistance measured before and after the heat-run. The temperature of the commutator to be determined by placing a thermometer on the commutator as soon as the generator is stopped, covering it with waste and taking its highest reading as the temperature of the commutator.

31. In addition to the heat-run prescribed in paragraph 30, each generating set shall be tested by running it for a period of two hours with an overload of thirty-three (33) per cent. of the full-rated capacity of the generator. The set must be capable of sustaining this overload for the period of time prescribed without injury to any part either of engine or generator. The engine shall have ample power to give the armature the speed necessary to produce the normal voltage, and no part of the generator shall heat to such a degree as to injure the insulation.

32. The windings of the dynamo, both field and armature, must be well protected from mechanical injury, and must be painted with a water-excluding material.

33. The insulation resistance of the generator circuits from each other, of each from the frame, and of the frame from the combination bed-plate, shall not be less than one megohm, the measurements to be taken with pressures not greater than 1000 volts before and after each run. No insulating substance that could be injured by moisture or by a temperature of 200° F. shall be used.

34. The change of voltage at the terminals of the generator as measured on a deadbeat voltmeter shall not exceed ten volts when full load is suddenly thrown on or off.

35. The field rheostats must have sufficient range to compensate for the increased resistance of the field coils due to their heating. They must be mounted in incombustible frames.

INCANDESCENT ELECTRIC LAMPS.

1. Lamps will be classed as follows:

Standard lamps.

Instrument lamps.

2. The following are the standard lamps allowed:

16 candle power, clear.

16 candle power, frosted.

32 candle power, clear.

150 candle power, clear.

3. All standard lamps must conform to the following specifications:

First. Their principal, external, over-all, dimensions must be in exact conformity with the design approved by the Bureau, November, 1896, and February, 1897. [Blue print No. 827 C.]

Second. They must be of the best quality and finish and uniform in size; the bases must fit and be interchangeable in the standard socket.

Third. All leading-in wires and anchors must be fused in the glass; all anchors must be made of metal.

Fourth. The filaments must be centered in the bulb and must not droop when the lamps are run in a horizontal position.

Fifth. Each lamp must be marked on the inside of the bulb with the date of manufacture, and must have its rated candle power, the voltage necessary to give this candle power and the name of the manufacturer conspicuously labelled on the outside of the bulb.

Sixth. The material used for cementing the bases to the bulb must be so treated as to ensure against danger of short circuiting the lamp when exposed to moisture. When porcelain is used all holes must be filled.

Seventh. They must be designed for 80 volts, the rated candle power to be given at not less than 78 nor more than 82 volts. No fraction of a volt beyond these limits will be permitted.

Eighth. The efficiency of all 16 c. p. and 32 c. p. lamps must not be less than $3\frac{1}{8}$ nor more than 4 watts per candle power, and that of 150 c. p. lamps not less than $3\frac{1}{4}$ nor more than $3\frac{1}{2}$ watts per candle power, the efficiency to be measured when the lamps are new.

Ninth. The contractors shall guarantee that all lamps supplied will have an average life of at least 600 hours, and that the rated candle power shall not have decreased more than 20 per cent. after burning for this length of time at the initial potential.

4. *Instrument Lamps.*—The following are the standard types allowed:

5 candle power, 80 volt, clear.

1 candle power, 10 volt, clear.

5. Instrument lamps must conform to the following specifications:

First. Their principal, external, over-all dimensions must be in exact conformity with the designs approved by the Bureau, February, 1897.

Second. They must be of the best quality and finish and uniform in size; the bases must fit and be interchangeable in the prescribed socket.

Third. The material used for cementing the bases to the bulb must be so treated as to insure against danger of short circuiting the lamp, when exposed to moisture.

Fourth. The rated candle power must be conspicuously marked on the outside of the bulb and the voltage and amperage necessary to give this candle power must be etched on the glass.

6. *Tests*.—Before acceptance a test lot will be selected at random from the lot of each type of lamp delivered as follows:

From lots not exceeding 50 lamps, all lamps.

From lots exceeding 50, but not exceeding 500, 50 lamps.

From lots exceeding 500 lamps, 10 per cent. of the lot.

7. The test lot will be subjected to the following tests:

(a) For design, dimensions and construction.

(b) For vacuum, by trembling of filament and spark from an inductorium.

(c) For voltage and efficiency when rotating at a speed of 180 revolutions per minute.

(d) For rated candle power, by standard photometer.

8. A secondary standard lamp, standardized from the Bureau's standards, will be used in the tests.

9. A failure of 30 per cent. of the test lot to comply with foregoing specifications will cause rejection of the lot represented by that test lot.

10. All lamps whose bulbs shall burst or whose filaments shall break or burn out under test, or which have been found to have been injured in transit will be rejected from the delivery and must be replaced at the expense of the contractor.

11. When test lots are selected at the contractor's works by an Inspector appointed by the Bureau, the lots so selected shall be immediately sent, free of expense to the Government, to the New York Navy Yard for test, and no test will be made until advice has been received that the delivery represented by such test lots is ready for shipment.

SPECIFICATIONS FOR WIRING APPLIANCES.

STANDARD WIRING APPLIANCES.

These shall be of two general classes; water-tight (W. T.) and non-water-tight (N. W. T.).

The following are the standard water-tight appliances:

Junction boxes:

(a) Feeder; (b) main; (c) branch 3-way; (d) branch 4-way.

Switches:

(a) Single pole, 5-ampere; (b) double pole, 25-ampere; (c) double pole, 50-ampere; (d) double pole, 100-ampere; (e) double pole, double throw, 50-ampere (transfer).

Receptacles:

(a) 5-ampere; (b) search-light; (c) controller.

Combination switch and receptacles:

(a) 5-ampere; (b) 25-ampere.

*Distribution boxes.**Stuffing tubes:*

(a) Box; (b) bulkhead, types L. and S.; (c) deck, types P. and W.; (d) protective deck types P. and W.; (e) washer.

Soft rubber gaskets:

Types A, B, C, D and E.

The following are the standard nonwater-tight appliances:

Junction box:

(a) Branch 3-way; (b) branch 4-way.

*Switch.**Receptacle.**Sockets:*

(a) Key; (b) keyless; (c) wall.

SPECIFICATIONS FOR WATER-TIGHT JUNCTION BOXES.

Principal parts: the box; the cover; the interior fittings.

The Box.

To be made of brass composition.

Wire Leads.

The wires to be led into the junction boxes through stuffing tubes in the ends and side as follows: Main junction box, two stuffing tubes in each end. Feeder junction box, two stuffing tubes in each end and two in one side. Three-way branch junction box, two stuffing tubes in each end and two in one side. Four-way branch junction box, two stuffing tubes in each end and two in each side.

The cover of the main junction box to be plain, without hole or cap.

The cover and cap of all boxes to be finished on the outside in a very dark, durable color.

Interior Fittings.

The interior insulating blocks of all junction boxes to be of unglazed vitreous porcelain, rectangular in shape. Sheet mica, not less than 25 mils in thickness, to cover the bottom of all boxes, beneath the insulating block.

The interior conductors, leading to the side and end holes of the feeder junction box, to be made of copper having a conductivity of at least 96 per cent. of that of pure copper; and to have a cross section of not less than 0.06 square inch.

The conductors of opposite polarity must be separated at least $\frac{1}{8}$ inch from each other and from the metal of the box.

Each conductor leading from the side to the end stuffing tubes to be divided, and to be so fitted that the gaps may be bridged either by copper connecting strips of the same area of cross section as the conductors themselves, or by copper-tipped safety fuses. To be furnished with both copper connecting strips, fuses and micanite cups, for use either with or without fuses.

The main junction box to be without fuses. The two interior conductors to lead direct from one end of the box to the other, on opposite sides of the insulating block; each to have a cross section of 0.06 square inch, and to be made of copper having a conductivity of at least 96 per cent. of that of pure copper; to be separated at least $\frac{1}{8}$ inch, as provided in the feeder box.

The branch junction box to be fitted with two fuses in glass tubes, one fuse in each pole, and both fuses on each branch circuit. The clips for fuses to be of phosphor-bronze, and to have a stout guard secured under and bent outside of each clip, to prevent its being bent out and broken off.

The interior conductors for end stuffing tubes to have a cross section of 0.03 square inch, and to be made of copper having a conductivity of at least 96 per cent. of that of pure copper; to be separated at least $\frac{1}{8}$ inch, as provided in the feeder box. The branch binding posts to be for No. 14 B. & S. G. wire.

The binding straps for wires to be designed to take wire up to and including a diameter of 0.4073 inch (124928 cm.). To have their centers opposite the centers of the stuffing tubes in the box through which the wires are led.

The interior metal parts of all boxes, and the conductors, to be roughly finished; polishing not being required.

WATER-TIGHT SWITCHES.

(a) *Single Pole, 5-amperes.*

The box to be made of brass composition.

To be finished on the outside in a very dark, durable color.

The branch wires to be led into the box through two stuffing tubes in one end, which will be exactly similar to the side stuffing tubes in the branch junction boxes, the same distance between centers, and fitted with the same stuffing box, glands and washers.

The switch stem to pass through a hole in the cover. This hole to be surrounded by a raised circular wall with a male screw on outside for screw collar. To be packed water-tight by means of a screw collar and washer, with a soft-rubber gasket.

The interior insulating blocks to be of unglazed vitreous porcelain; to be rectangular in shape.

Sheet mica, not less than 25 mils thick, to cover the entire bottom of the box, beneath the porcelain block.

The switch to be quick break. The switch block to be made of porcelain, the contact springs of phosphor-bronze.

(b) *Double Pole, 25-amperes.*

The box to be made of brass composition.

The wires to be led into the box through two stuffing tubes in each end, which will be exactly similar to the side stuffing tubes in the branch junction boxes; the distance between centers to be $1\frac{1}{8}$ inch; to be fitted with the same stuffing box, glands and washers.

The switch stem to pass through a hole in the cover. This hole to be

surrounded by a raised circular wall, with a male screw on outside for screw cap. The cap for closing the box water-tight to be secured to the box by a stout chain; the edge of the cap to be milled.

The interior insulating block to be unglazed vitreous porcelain; rectangular in shape.

Sheet mica, not less than 25 mils thick, to cover the entire bottom of the box beneath the block.

The switch to be quick break, double pole; switch block to be of unglazed porcelain, the contact springs of phosphor-bronze. The switch stem to be without a handle, but to be fitted to take and be turned by a standard wrench. The cap for closing the hole in the cover water-tight to be solid, and high enough to clear the end of the switch stem. The cap to be removed when shipping the wrench for operating the switch.

(c) Double Pole, 50-ampere.

The box to be made of brass composition.

The wires to be led into the box through two stuffing tubes in each end, which will be exactly similar to the end stuffing tubes in the feeder junction box, the same distance between centers, and fitted with the same stuffing box, glands and washers.

The cap for closing the box water-tight to be secured to the box by a stout chain; the edge of the cap to be milled.

The interior insulating block to be unglazed vitreous porcelain; rectangular in shape. Sheet mica, not less than 25 mils thick, to cover the entire bottom of the box beneath the block.

The switch to be quick and break, double pole. The switch stem to be without a handle, but to be fitted to take and be turned by a standard wrench. The cap for closing the hole in the cover water-tight to be solid, and high enough to clear the end of the switch stem. The cap to be removed when shipping the wrench for operating the switch.

(d) Double Pole, 100-ampere.

The box to be made of brass composition.

The wires to be led into the box through two stuffing tubes in each end, which will be exactly similar to the end stuffing tubes in the feeder junction box, the same distance between centers, and fitted with the same stuffing box, glands and washers.

The switch stem to pass through a hole in the cover. This hole to be surrounded by a raised circular wall, with a male screw on outside, 18 threads to the inch, for screw cap. The cap for closing the box water-tight to be secured to the box by a stout chain; the edge of the cap to be milled.

The interior insulating block to be unglazed vitreous porcelain; rectangular in shape. Sheet mica, not less than 25 mils thick, to cover the entire bottom of the box beneath the block.

The switch to be quick break, double pole. The switch stem to be without a handle, but to be fitted to take and to be turned by a standard wrench. The cap for closing the hole in the cover water-tight to be solid,

and high enough to clear the end of the switch stem. The cap to be removed when shipping the wrench for operating the switch.

(e) Double Pole, Double Throw, 50-ampere.

The box to be of brass composition.

The wires to be led into the box through two stuffing tubes in each end and two in one side, which will be exactly similar to the end stuffing tubes in the feeder junction box, the same distance between centers, and fitted with the same stuffing box, glands and washers.

The switch stem to pass through a hole in the cover. This hole to be surrounded by a raised circular wall, with a male screw on outside for screw cap. The cap for closing the box water-tight to be secured to the box by a stout chain; the edge of the cap to be milled. Sheet mica, not less than 25 mils thick, to cover the entire bottom of the box beneath the block.

The switch to be quick break, double pole, and double throw, in order to transfer the current from the wires entering at the side stuffing tubes to either pair of those entering at the end stuffing tubes. The interior conductors to be of stamped copper, having a conductivity of at least 95 per cent. of that of pure copper, and of ample area of cross section to carry a current of 40 amperes without heating. The switch stem to be without a handle, but to be fitted to take and be turned by a standard wrench. The cap for closing the hole in the cover water-tight to be solid, and high enough to clear the end of the switch stem. The cap to be removed when shipping the wrench for operating the switch.

SPECIFICATIONS FOR WATER-TIGHT RECEPTACLES.

(a) 5-ampere.

The box cover and insulating block to be in every way similar to the water-tight switch, (a) single pole, 5-ampere box, cover and block respectively, excepting the hole in the cover, which will be adapted for a receptacle plug instead of for the switch stem.

The receptacle plug to be of hard rubber, screwed and cemented into its socket, with contact plates and binding screws on each side. To be fitted with stuffing box and screw collar, so arranged as to be water-tight. Stuffing box and screw collar, so arranged as to be water-tight. Stuffing gland to be identical with those for side stuffing tubes of branch junction boxes. The cap for closing the box water-tight, when the plug is withdrawn, to be secured to the box by a stout chain. The edge of both cap and collar to be milled. The recess of the collar which takes on the top of the wall to be filled with a 1-ply cloth-insertion rubber gasket.

The clips for the receptacle plug to be of phosphor-bronze, and each of the shape of an inverted U, with one end secured and the other free.

(b) Search-light.

The box to be made of brass composition.

The plug cap to consist of a disk of hard rubber. To be perforated with two holes $\frac{1}{2}$ inch in diameter, and fitted on the washer side with

four brass pins, No. 9 B. & S. G., to secure the metal plug from turning and short circuiting.

The cap plate to be of brass composition.

The plug caps to be fitted in a collar, inside threaded; this collar to screw to the threads on the outside of the wall of the cover.

The metal plugs to consist of a brass block, corners of one side rounded to fit in the rubber disk; the block to be drilled with two holes, in opposite corners, to fit over pins in rubber disk; a hollow post terminal to be turned from the brass block. A copper connection strip to be sweated into a slot in the block.

The copper connection strip for one terminal to have a brass through pin. The lower edges of these connection strips to be rounded off.

The post terminal to have a male thread, 20 to the inch, throughout its length, over which fits a hard-rubber cap, with a central hole carrying a female thread to within $\frac{1}{4}$ inch of the top, to fit screw thread of post terminal.

This hard-rubber cap to pack the wire water-tight, and to have a shoulder to fit on the cap plate; to be rounded at the top and polished.

The insulating block to be of unglazed vitreous porcelain; rectangular in shape. Sheet mica, not less than 25 mils in thickness, to cover the bottom of the box beneath the block.

The interior conductors to be of copper having a conductivity of 96 per cent. of that of pure copper, to be separated $\frac{1}{2}$ inch; swelled at the ends to receive a large brass strap for securing the wires.

The plug spring clips to consist of two copper plates, soldered into slots in the upper face of each conductor; separated $\frac{1}{8}$ inch from each other. Each plate to be bevelled on the inside to admit the plug, and split in the center of its width.

The end stuffing tubes to be fitted as described in end stuffing tubes of junction boxes.

A cap to cover the hole in the cover, when plug cap is not inserted, to be the same as described in feeder junction boxes; to be secured to the box with a stout chain.

(c) *Controller.*

The box to be made of brass composition.

The cover to be similar to that for branch junction boxes, and fitted on the inside with a guide pin to correspond with set in coupling contact.

The wires to be led through two stuffing tubes in each end and three stuffing tubes in one side, the same as described in side stuffing tubes of branch junction boxes.

The insulating block to be of unglazed vitreous porcelain, rectangular in shape. The insulating block to have a recess at each of the screw holes to receive the bosses.

The conductors to be seven in number.

Between the two strips of each conductor is to be clamped a clip of phosphor-bronze, turned up and bent into the shape of an inverted U, the inside end to be free.

COMBINATION SWITCH AND RECEPTACLES.

(a) 5-ampere.

The box, cover and insulating block to be in every way similar to the water-tight switch, (a) single-pole, 5-ampere box, cover, and block respectively, excepting that the cover shall have at one end a hole for the switch stem as described under switch, (a) single-pole, 5-ampere, and at the other a hole for the receptacle plug, as described under receptacle, (a) 5-ampere. The interior fittings to consist of a single-pole 5-ampere switch at one end of the insulating block, and clips for a 5-ampere receptacle plug at the other.

(b) 25-ampere.

The box, cover and insulating block to be in every way similar to the water-tight switch, (b) double-pole, 25-ampere, excepting that the cover shall have at one end a hole for the switch stem, as described under switch, (b) double-pole, 25-ampere, and at the other, two holes for receptacle plugs; each hole to be as described under receptacle, (a) 5-ampere. The interior fittings to consist of a double-pole 25-ampere switch at one end of the insulating block, and two sets of clips for 25-ampere receptacle plugs at the other. The plugs to be the same as for the 5-ampere receptacle, excepting that the contact plates are in one piece, extending like a strap around the end of the plug, with a binding screw on each side.

All of the switches herein described shall be so designed that the switch shall be "on" when the switch handle is lengthwise of the box, and "off" when it stands across the box. In the case of the large switches which are turned by means of a standard wrench instead of by a permanent switch handle, the wrench and end of the switch stem must be so designated that the former cannot be shipped unless it is put on lengthwise of the box when the switch is "on," and across the box when "off."

DISTRIBUTION BOXES.

The case to be of cast metal, of construction sufficient to withstand rough usage or accident from heavy tools.

The interior fittings to be the same as described in branch junction boxes, and of such number as may be required for the particular compartment or location. Two-ply cloth-insertion rubber packing to separate the fittings from the bottom of the case. The case to have a boss opposite the center line of each branch terminal of the interior fittings. In case any branch of the fittings is not needed for immediate use its boss shall be plugged.

Bosses for conduits carrying the mains to be fitted on the ends, or on the sides near the end, as may best suit the requirements of the location.

Sufficient room for convenience of connecting the mains to be allowed on the inside of the case at the ends.

The cover to be of the same material as the case; to be secured to the case by thumb nuts on swinging screws attached to the sides and corners of the case between the bosses.

The cover to be made water-tight by a gasket of 2-ply cloth-insertion rubber packing.

There shall be no lettering on the outside of the boxes of any of the foregoing wiring appliances.

JUNCTION BOXES (NON-WATER-TIGHT).

(a) 3-way; (b) 4-way.

The box, interior fittings and wire leads to be as specified for the branch water-tight junction boxes. No washer to be placed between the cover and top of the box.

The cover to have a hole for the purpose of inspecting the fuses, with a raised circular wall.

The cap to be neat fit over the wall, closing flush with the top of the cover; to be hinged to the cover and secured by a strong snap spring fastened to inside of cap and closing on inside of cover.

SWITCH (NON-WATER-TIGHT).

The base to be of glazed vitreous porcelain, circular in shape; to be single-pole, snap, quick-break. The springs to be of phosphor-bronze.

The switch stem and handle to be of metal, insulated from springs and contacts; the handle to screw to the stem and be secured by a headless set screw; the handle to prevent removal of the cover when secured to the stem.

The cover to be of brass composition finished in a very dark, durable color; to be circular in section seating in a recess in the porcelain block, and having a notch in its lower edge fitting over a lug in the porcelain to prevent turning in its seat.

The switch to have a capacity of 10 amperes and to operate in one direction only.

FUSES.

The character of the alloy composing the fuses shall be such that there shall be no reddening or excessive elongation when the current is slowly carried up to the fusing point, which will be at double the capacity. An excess of 50 per cent. is to be steadily carried without any effect.

The fuses for the wall sockets shall be of the copper-tipped commercial pattern, $1\frac{1}{8}$ inch between tips and of 4-ampere capacity.

The fuses for branch junction boxes shall be of the copper-tipped glass-tube type and of 4-ampere capacity.

The glass tube shall be $1\frac{1}{4}$ inch long, $\frac{1}{2}$ inch external diameter, $\frac{1}{4}$ inch internal diameter.

The copper ends shall be $\frac{1}{4}$ inch external diameter, $\frac{1}{2}$ inch long, spaced $\frac{3}{4}$ inch apart, and cemented to the glass tube. The ends of the fuse wire to go through $\frac{1}{4}$ -inch holes in the center of the copper tips, and soldered to the outside ends.

The switch-board circuit fuses shall be of the standard push-clip copper-tip pattern required for the Board.

The copper shall be No. 18 B. & S. G. The distance between the tips to be $1\frac{1}{8}$ inch.

The rated capacities are to be 10, 15, 20, 30, 40, 50, 60, 75 and 100 ampere

The fuses to be made up of wire or strip as required.

The rated capacity to be stamped on the face of one of the lugs.

The fuses for feeder boxes shall be of the copper-tipped commercial pattern. The slots in the tips to be for No. 8-32 machine screws. The distance between the tips to be 1 inch. The rated capacities to be 10, 15, 20, 30, 40, 50, 60, 75 and 100 amperes. The fuses to be made up of wire or strip as required. The rated capacity to be stamped on the face of one of the tips.

Fuses for dynamo circuits on the switch-board shall be of the commercial slotted copper-tip type. The slots being at right angles to each other for $\frac{3}{4}$ -inch bolts. The copper shall be adapted in thickness to the capacity of the fuse. The distance between the tips to be $\frac{3}{8}$ inch. The rated capacities to be 25, 50, 100, 200, 300, 400, 500 and 600 amperes. The fuses to be made up of wire or strip as required. The rated capacity to be stamped on the face of one of the tips.

SPECIFICATIONS FOR STUFFING TUBES.

Stuffing tubes are used for making water-tight the holes in deck bulkheads, etc., through which wires are run, and are designated as follows:—Box: sizes 14, 18, 26, 36 and 42. Bulkhead: types L. and S., size 14, 18, 26, 36 and 42. Deck: types P. and W., sizes 14, 18, 26, 36 and 42. Protective deck: types P. and W., sizes 14, 18, 26, 36 and 42. Washer sizes 14, 18, 26, 36 and 42.

The terms "Bulkhead," "Deck," etc., indicate where used; the two letters L. and S., whether a long or short tube is required, and P. and W. the character of the deck, whether plain steel or steel covered with wood. The size number expresses in thirty-seconds of an inch, the inside diameter of the hard-rubber lining of the tube. Thus stuffing tube, Deck-P-26 signifies a tube for use in connection with a plain steel deck, the inside diameter of the hard-rubber lining of the tube being $1\frac{1}{2}$ of an inch.

All tubes shall be made in strict conformity with the Bureau's designs, of seamless brass tubing of commercial iron pipe sizes, lined with standard No. 1 quality of hard-rubber tubing. The sizes of both brass and hard-rubber tubing to be the same for tubes of like sizes of all varieties, and the fittings for all tubes of the same size to be strictly interchangeable.

The hard-rubber lining to be flush with the brass tubing at the upper end, and to project beyond the brass tubing at the lower end $1\frac{1}{4}$ inch, for all tubes excepting box tubes, in which it shall project $\frac{1}{8}$ inch only.

All tubes to be fitted at the upper end with standard stuffing glands and washers; and the hard-rubber tubing to be reamed out to take the standard soft-rubber gasket of the proper size for each tube. The gland to have six holes in face, and six in rim, No. 32 drill, for a straight spanner. The spanner to be made of No. 33 Stubs' steel wire, $2\frac{1}{4}$ inches long. The inner and outer edges of the gland, and the inner edges of the washer to be rounded.

Box Tube.

To have the thread for the gland continued the entire length of the brass tubing.

Bulkhead Tube and Deck Tube.

To have a standard, right-handed pipe thread, corresponding to the iron pipe size of the tube, cut at the lower end of the brass tubing.

Protective Deck Tube.

To have the external diameter of the brass tubing reduced at the lower end, and to have a standard right-handed pipe thread, corresponding to the iron pipe size of the tube, cut at the bottom of the full-sized portion. The sum of the lengths of the pipe thread and the reduced portion, to equal the thickness of the steel deck or armor.

Washer Tube.

To have a straight thread, 14 to the inch, cut on the lower end. To be furnished singly or in pairs, with hexagonal brass nuts, and single or double washer plates as required.

SOFT-RUBBER GASKETS.

To be of rubber composition containing not less than 60 per cent. nor more than 65 per cent. of pure rubber.

To be of five types, which will be designated as follows: Type A, Type B, Type C, Type D, and Type E.

Type A.

The shape to be that of two truncated cones of unequal heights joined base to base; diameter top and bottom $1\frac{1}{2}$ inch, diameter cone bases $1\frac{1}{2}$ inch; the shorter cone to taper from smaller to larger diameter in a height of $\frac{3}{8}$ inch, and the larger cone in a height of $1\frac{1}{4}$ inch; total length of gasket $1\frac{1}{4}$ inch. To be perforated with a central hole the full length of the gasket.

Gaskets of the type to be designated by the type letter followed by a size number signifying the diameter of the central hole in thirty-seconds of an inch, as A.30, A.36, etc.

There will be a solid gasket of the type to be designated A.o.

Type B.

The shape to be as prescribed for type A; diameter top and bottom $\frac{7}{8}$ inch, diameter cone bases $1\frac{1}{8}$ inch; the shorter cone to taper from smaller to larger diameter in a height of $\frac{3}{8}$ inch, and the larger cone in a height of $1\frac{1}{8}$ inch; total length of gasket $1\frac{1}{4}$ inch. To be perforated with a central hole the full length of the gasket.

Gaskets of the type to be designated as prescribed for type A, as B.13, B.28, etc.

There will be a solid gasket of the type to be designated B.o.

Type C.

The shape to be as prescribed for type A; diameter top and bottom $1\frac{1}{2}$ inch, diameter cone bases $\frac{3}{8}$ inch; the shorter cone to taper from smaller to larger diameter in a height of $\frac{3}{8}$ inch, and the larger cone in a height of $\frac{1}{2}$ inch; total length of gasket $\frac{3}{4}$ inch. To be perforated with a central hole the full length of the gasket.

Gaskets of the type to be designated as prescribed for type A, as C.20, etc.

There will be a solid gasket of the type to be designated C.o.

Type D.

The shape to be as prescribed for type A; diameter top and bottom $\frac{1}{2}$ inch, diameter cone bases $\frac{1}{4}$ inch; the shorter cone to taper from small to larger diameter in a height of $\frac{1}{8}$ inch, and the larger cone in a height of $\frac{1}{8}$ inch; total length of gasket $\frac{1}{4}$ inch. To be perforated with a central hole the full length of the gasket.

Gaskets of the type to be designated as prescribed for type A, as D.; D.14, etc.

There will be a solid gasket of the type to be designated D.o.

Certain ones of the foregoing types of gasket will be required to be perforated lengthwise, with two holes, parallel and of the same diameter separated equally from each other and from the outer circumference of the gasket. Such gaskets will be designated by a double type letter, followed by a number specifying the diameter of the holes in thirty-second of an inch; thus C. C. 6, etc.

Type E.

The shape to be that of a sphere; diameter of sphere $1\frac{1}{2}$ inch. To be perforated by a central hole. Gaskets of the type to be designated as prescribed for type A, as E.32, E.34, etc.

CONDUIT AND MOLDING.

Conduit.

To be of seamless drawn iron or steel tubing of commercial iron pipe sizes, and to have a continuous lining tube of approved insulating material.

Conduit for magazines to be made of seamless brass tubing, to be lined with hard rubber, unless otherwise specified.

Flexible Conduit.

In locations subject to mechanical stress, such as inside of steel masts or when flexibility is desired, flexible conduit of approved design may be used.

Molding.

Molding will be in two pieces; that part containing the gutters for the wire will be known as molding, and the other part as the backing strip.

To be of well-seasoned wood; where run over hard-wood surfaces to be of the same material as the surface; the bottom of all gutters to be semi-circular in section; width and depth of all gutters to be the same.

Backing strip to be of the same material and width as the molding with which it will be used, perfectly plain, and of a thickness (at least $\frac{3}{8}$ of an inch) sufficient to cover all rivet heads, bolt heads and nuts; straps and flanges to make a smooth bed for the molding; all capping to be of the same width as the molding, $\frac{3}{8}$ inch thick, and to be screwed to the side walls.

Molding for all feeders and wires of 60088 cm. to 124928 cm. inclusive

will be 3 inches wide, $1\frac{1}{2}$ inch deep, including capping; to have two gutters, each $\frac{3}{4}$ inch wide and $\frac{3}{4}$ inch deep, separated by a $\frac{3}{4}$ -inch wall; outside walls to be $\frac{3}{8}$ inch.

Molding for wires below 60088 cm. will be $\frac{3}{4}$ inch wide, $1\frac{3}{8}$ inch deep, including capping; to have two gutters each $\frac{5}{8}$ inch wide and $\frac{5}{8}$ inch deep, separated by a $\frac{3}{4}$ -inch wall; outside walls to be $\frac{3}{8}$ inch thick.

Molding for Motor-controlling Circuits.

To be $4\frac{1}{8}$ inches wide, $2\frac{1}{8}$ inches deep, including capping; to have three gutters, each $\frac{5}{8}$ inch wide and $\frac{5}{8}$ inch deep, separated by $\frac{3}{4}$ -inch walls; outside to be $\frac{3}{8}$ inch; capping to be $3\frac{3}{8}$ inches wide by $\frac{3}{8}$ inch thick.

Molding for Dynamo Mains and Shunt Rheostat Leads.

To consist of two moldings and a capping of the same width, capping to be $\frac{3}{8}$ inch in depth; the first molding (next to backing strip) to have three gutters to carry the terminal and equalizer mains. The second to be 1 inch in depth, to act as a capping to the first; to have two gutters, $\frac{5}{8}$ inch wide, for the shunt rheostat lead; the capping to fit the second molding. Gutters to be symmetrically placed and to have same width and depth. Backing strip to be of same width as molding, and to have a depth of $1\frac{1}{4}$ inch. Dimensions corresponding to leads are tabulated in inches as follows:

Amperes.	Width.	First Molding.				Second Molding.	
		Depth.	Gutters.			Gutters.	
			Width.	Between centers.	Outside wall.	Between centers.	Outside wall.
	In.	In.	In.	In.	In.	In.	In.
50	$4\frac{3}{4}$	$1\frac{3}{4}$	$\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$2\frac{3}{4}$	$\frac{1}{8}$
100	$5\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{3}{4}$	$\frac{1}{8}$	$3\frac{1}{8}$	$\frac{1}{8}$
200	$6\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	2	$\frac{1}{8}$	$3\frac{1}{2}$	$\frac{3}{4}$
300	7	$1\frac{3}{8}$	$1\frac{1}{4}$	$2\frac{1}{4}$	$\frac{5}{8}$	$3\frac{3}{4}$	$1\frac{1}{8}$
400	$7\frac{3}{4}$	$2\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{1}{2}$	$1\frac{1}{8}$	$4\frac{1}{8}$	$1\frac{1}{8}$
500	$8\frac{1}{2}$	$2\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{3}{4}$	$\frac{3}{4}$	$4\frac{1}{2}$	$1\frac{3}{8}$
625	$9\frac{1}{4}$	$2\frac{1}{2}$	$1\frac{1}{4}$	3	$1\frac{1}{8}$	$4\frac{3}{4}$	$1\frac{1}{8}$

SPECIFICATIONS FOR SOCKETS.

Sockets to be of three kinds: (a) standard key socket; (b) standard keyless socket; (c) wall socket.

Standard key and keyless sockets must conform strictly to the Bureau's designs.

They must be of the spiral-spring type and mounted on porcelain; the spring to be made of No. 11 B. & S. G. phosphor-bronze wire. The shells to be of punched brass 0.016 inch thick. The base of the spiral spring must be firmly secured to a metal plate or divided ring by means of metal binders of a suitable kind, in addition to soldering; and the whole to be secured to the porcelain with ample strength to withstand the torsional strain of screwing a lamp into the socket.

The nozzle in the base to be threaded inside, with $\frac{3}{8}$ -inch pipe thread. All sockets must fit the standard incandescent lamp.

Dimensions will be: total length $2\frac{1}{4}$ inches, largest diameter $1\frac{1}{2}$ inch. The spiral spring must be insulated from the shell at the top by an insulating ring of hard rubber.

Instrument Lamp Sockets.

To be of commercial type, with a receptacle to fit the butts of the standard instrument lamp; to be mounted on a porcelain base; the base to be circular or rectangular as directed.

All insulating material to be treated to prevent absorption of moisture.

Key and Keyless Sockets.

To be of commercial type, polished, with D. P. fuse; the receptacle to fit the standard incandescent lamp; to be mounted on a circular porcelain base, $3\frac{1}{4}$ inches in diameter. The receptacle to be insulated from the shell at the top by a hard-rubber insulated ring; to be finished in dark bronze or silver plate, as required.

When specially directed these sockets will be fitted with the spiral spring described in standard sockets, in lieu of the commercial receptacle.

Attachment plug for commercial wall sockets to be of hard rubber without fuses.

INTERIOR COMMUNICATION.

WIRING APPLIANCES.

Cut-out Switch.

To be of four sizes, taking 5, 10, 15 or 20 conductors, and designated Types A-5, A-10, A-15 and A-20 respectively. The several circuits through the switch to be normally closed, but capable of being simultaneously opened by the throw of an insulating strip, mounted on a spindle running the length of the box.

Box.

To be of cast brass provided with standard box stuffing tubes, as required.

To have internal bosses, supporting the strips of micanite which bear the contact springs.

To be provided with brass hinge bolts and wing nuts for the cover; to be flanged inward at the top to form a seat for the cover washer.

To be secured in place by brass screws sunk in wells, the wells to be packed water-tight by the washer.

Cover.

To be of cast brass having projecting lugs to receive the hinge bolts.

To be fitted with a 2-ply cloth-insertion sheet-rubber washer, held in place by screws.

To show on the outer side the words "Cut-out switch," also the type letter and number, and a serial number.

Contact Springs.

To be of phosphor-bronze, No. 17 B. & S. G., clamped to micanite strips by brass machine screws tapping into terminal blocks beneath the micanite.

Terminal Blocks.

To be of cast brass, having a boss for wire terminal connections.

Spindle.

To be of cast brass, slotted to receive an insulating piece of hard rubber, adapted to actuate the contact springs.

To be firmly held in either open or closed position by a spring of phosphor-bronze, No. 17 B. & S. G.

Wire Terminals.

To be of soft copper, No. 20 B. & S. G., and supplied in sufficient quantity to make the necessary connections in the switch. To have a space for stamping the number of the wire lead.

BATTERY TRANSFER SWITCH.

To be designated Type A, and made with as many sections as required.

Each section to throw into any one of three positions, "Battery," "Off," and "Transformer"; the contacts being made through brass pins set in an insulating disc.

Box.

To be of cast brass provided with standard box stuffing tubes, as required.

To have internal bosses to support strips of micanite bearing the contact springs, and other bosses adapted to form bearings for the spindles of the insulating discs.

To be provided with brass hinge bolts and wing nuts for clamping the cover, and to be flanged inward at the top to form a seat for the cover washer.

To be secured in place by brass screws sunk in wells, the wells to be packed water-tight by the washer.

Cover.

To be of cast brass, having projecting lugs to receive the hinge bolts.

To be fitted with a 2-ply cloth-insertion sheet-rubber washer, held in place by screws.

To show on the outer side the words "Battery transfer switch," the type letter followed by a number showing the number of sections and a serial number.

Contact Springs.

To be of phosphor-bronze, No. 17 B. & S. G., and clamped to micanite strips by brass machine screws tapping into terminal blocks beneath the micanite.

Terminal Blocks.

To be of cast brass, having a boss for connecting wire terminals.

Insulating Discs.

To be of hard rubber; the upper end milled to serve as a handle, the lower end having a projecting brass spindle.

To have two brass pins diametrically opposite each other, passing through and projecting slightly from the disc.

Wire Terminals.

To be of soft copper, No. 20 B. & S. G., with a space for stamping the wire number, and supplied in sufficient quantity to make the necessary connections in the switch; to have a space for stamping the number of the wire lead.

CONNECTION BOX.

To be made in two sizes, taking 20 or 40 conductors, and designed Types A-20 and A-40 respectively.

Box.

To be of cast brass, provided with standard box stuffing tubes, as required.

To have internal lugs to support a porcelain insulator.

To be provided with brass hinge bolts and wing nuts for clamping on the cover, and to be flanged inward at the top to form a seat for the cover washer.

To be secured in place by cap bolts passing through external lugs, or by brass screws sunk in wells; the wells to be packed water-tight by the cover washer.

Cover.

To be of cast brass, having projecting lugs to receive the hinge bolts.

To be fitted with a 2-ply cloth-insertion sheet-rubber washer held in place by screws.

To show on the outer side the words "Connection box," the type number and letter, and a serial number.

Porcelain.

To have ridges on its upper surface, between which the binding posts are fitted.

To rest upon soft-rubber washers, and to be held in place by brass machine screws, passing through suitable bosses.

Binding Posts.

To be of cast brass, having a boss for connecting wire terminals.

Wire Terminals.

To be of soft copper, No. 20 B. & S. G., with a space for stamping the wire numbers; 40 and 80 wire terminals to be furnished with boxes A-20 and A-40 respectively.

Push Button (Water-tight).

To be enclosed in a cast brass case closing water-tight against a soft-rubber washer.

Contact springs to be platinum tipped, and mounted on an insulating plate.

All the foregoing appliances to conform strictly with the Bureau's designs.

Push Button (Nonwater-tight).

To be enclosed in a cast brass case. Diameter of base $2\frac{3}{8}$ inches, height of cover not more than $\frac{7}{8}$ inch.

Contact springs to be platinum tipped, and mounted on an insulating plate.

Push to be of black hard rubber.

Single-pear Push Button.

To be of black hard rubber, pear shaped, not longer than 3 inches, greatest diameter not more than $1\frac{1}{2}$ inch. The push to be at the lower end, and to be of metal heavily nickeled; contact to be made by a circular plate of metal, heavily nickeled, and held away from the contact screws by a spiral spring; contact screws to be heavily nickeled.

Double-pear Push Button.

To be of black, hard rubber, pear shaped, not longer than $3\frac{1}{2}$ inches, greatest diameter not more than $1\frac{3}{4}$ inch, thickness of shell not less than 0.15 inch. To have one push on the end and one on the side, and to be of metal, nickel plated; contact points to be platinum tipped.

Triple-pear Push Button.

To be of similar construction to the double-pear push button, not longer than $3\frac{1}{2}$ inches, greatest diameter not more than $1\frac{3}{8}$ inch. To have one push at the end, and one at each side, at opposite ends of the same diameter.

Molding.

Molding will be in two pieces, known as molding and backing strips, as described in molding for lighting circuits; to be well seasoned; where run over hard-wood surfaces to be of the same material as the surface, and of the following dimensions:

Two and one-quarter inch molding will be $2\frac{3}{4}$ inches wide, $1\frac{3}{4}$ inch deep, including capping; to have one gutter, 1 inch wide; side walls to be $\frac{5}{8}$ inch thick.

Two and one-half inch molding will be $2\frac{1}{2}$ inches wide, 2 inches deep, including capping; to have one gutter $1\frac{1}{4}$ inch wide; side walls to be $\frac{3}{4}$ inch thick.

Two and three-fourth inch molding will be $2\frac{3}{4}$ inches wide, $2\frac{1}{4}$ inches

deep, including capping; to have one gutter $1\frac{3}{8}$ inch wide; side walls to be $\frac{1}{4}$ inch thick.

All capping to be of same width as molding, and $\frac{3}{8}$ inch thick.

All backing strips to be of the same material and width as the molding, perfectly plain, and of a thickness (at least $\frac{3}{4}$ inch) sufficient to cover all rivet heads, straps, bolt heads, and nuts; and flanges to make a smooth bed for the molding.

Gutters to have the same depth and width; the cross section of the bottom of gutters to be semi-circular.

The foregoing specifications for wiring appliances are here intended as a guide only; the actual specifications cover all dimensions required.

SPECIFICATIONS FOR WIRE SUPPLIES.

1. All wire supplies will be classed as follows:

- (a) Lighting wire.
- (b) Bell wire.
- (c) Cable.

2. The following general specifications apply to all wire and cable:

First. All layers of pure Para rubber must contain at least ninety-eight (98) per cent. of pure Para rubber; must be of uniform thickness, elastic, tough, and free from flaws and holes.

Second. All layers of vulcanized rubber must contain not less than forty (40) per cent. nor more than fifty (50) per cent. of pure Para rubber; must be concentric, continuous and free from flaws or holes; must have a smooth surface and circular section; and must be made to a diameter in the finished conductor that will be in exact conformity with the diameter as tabulated.

Third. All layers of cotton tape must be filled with a rubber insulating compound, the tape to be of the width best adapted to the diameter of that part of the conductor which it is intended to bind. The tape must lap one-half ($\frac{1}{2}$) its width and be so worked on as to ensure a smooth surface and circular section of that part of the finished conductor which is beneath it.

Fourth. All exterior braid must be closely woven, and all, except silk braid, must be thoroughly saturated with an insulating water-proof compound which will neither be injuriously affected, nor have an injurious effect on the braid, at a temperature of 200° F. (dry heat), or at any stage of test, the conductor being sharply bent. Wherever a diameter over vulcanized rubber or outside braid is tabulated or specified, it is intended to secure a neat working fit in a standard rubber gasket of that diameter for the purpose of ensuring water-tightness of the joint, and no departure from such tabulated or specified diameter will be permitted.

SPECIFICATIONS FOR LIGHTING WIRE.

Lighting wire will be classed as single conductor and double conductor.

3. *Single Conductor*.—Table of standard dimensions:

Approx. C. M.	Actual C. M.	No. wires in strand.	Size of wire B. & S. G.	Diameter, inches.		Diameter in ³ / ₃₂ of an inch.		
				Over copper.	Over Para rubber.	Over vulc. rubber.	Over tape.	Over braid.
			No.					
4000	4107	1	14	.06408	.0953	7	9	11
9000	9016	7	19	.10767	.1389	10	12	14
11000	11368	7	18	.12090	.1522	10	12	14
15000	14336	7	17	.13578	.1670	10	12	14
18000	18081	7	16	.15225	.1837	11	13	15
20000	22799	7	15	.17121	.2025	12	14	16
30000	30856	19	18	.20150	.2328	12	14	16
40000	38912	19	17	.22630	.2576	13	15	17
50000	49077	19	16	.25410	.2854	14	16	18
60000	60088	37	18	.28210	.3134	15	17	19
75000	75776	37	17	.31682	.3481	16	18	20
100000	99064	61	18	.36270	.3940	18	20	22
125000	124928	61	17	.40734	.4386	19	21	23
150000	157563	61	16	.45738	.4885	20	22	24
200000	198677	61	15	.51363	.5449	22	24	26
250000	250527	61	14	.57672	.6080	24	26	28
300000	296387	91	15	.62777	.6590	26	28	30
375000	373747	91	14	.70488	.7381	29	31	33
400000	413639	127	15	.74191	.7732	30	32	34

WIRES USED IN STRANDS.

.....	1288	.....	19	.03589	.....	.....	.....	.....
.....	1624	.....	18	.0403	.....	.....	.....	.....
.....	2048	.....	17	.04526	.....	.....	.....	.....
.....	2583	.....	16	.05082	.....	.....	.....	.....
.....	3257	.....	15	.05707	.....	.....	.....	.....
.....	4107	.....	14	.06408	.....	.....	.....	.....

4. All conductors to be of soft annealed pure copper wire.

5. No single wire larger than No. 14 B. & S. G. to be used.

6. When greater conducting area than that of 14 B. & S. G. is required, the conductor shall be stranded in a series of 7, 19, 37, 61, 91 or 127 wires, as may be required; the strand consisting of one central wire, the remainder laid around it concentrically, each layer to be twisted in the opposite direction from the preceding, and all single wires forming the strand must be of the diameter given in the American wire gauge table as adopted by the American Institute of Electrical Engineers, October, 1893.

7. The material and manufacture of the strand must be such that the measured conductivity of each single wire forming the strand shall not be less than ninety-eight (98) per cent. of that of pure copper of the same number of circular mils, the measured conductivity of the conductor as a whole to be not less than ninety-five (95) per cent. of that of pure copper of the same number of circular mils.

8. Each wire to be thoroughly and evenly tinned.

9. All lighting conductors shall be insulated as follows:

First. A layer of pure Para rubber, not less than one sixty-fourth ($\frac{1}{64}$) of an inch in thickness taped or rolled on; if taped, the tape to lap one-half of its width.

Second. A layer of vulcanized rubber, of exact diameter as tabulated.

Third. A layer of commercial cotton tape, lapped to about one thirty-second ($\frac{1}{32}$) of an inch in thickness.

Fourth. A close braid to be made of No. 20 2-ply cotton thread, braided with three (3) ends for all conductors under 60,000 circular mils, and of No. 16, 3-ply cotton thread braided with four (4) ends for all conductors of and above 60,000 circular mils. The outside diameter over the braid to be in exact conformity with that tabulated.

10. *Tests*.—Two samples, each 500 feet long, will be selected by the Bureau from the coils of wire to be supplied, and must be sent by the contractors to the New York Navy Yard for test.

The tests will be as follows, failing to meet which, in any particular, will involve rejection of the lot corresponding to the samples.

(a) Both samples, after 24 hours' immersion in sea water, must have an insulation resistance of not less than 1000 megohms per nautical mile.

(b) Test to be at 72° F.

(c) To be tested by the direct deflection method at a potential of not less than 200 volts.

(d) Both samples will be tested for a conductivity of not less than 95 per cent. of that of pure copper, having a cross section of the specified number of circular mils.

(e) Chemical tests will be made to determine the constituents of the different layers of the insulation.

(f) Braid will be tested for water-proof qualities.

(g) Physical tests will be first made for qualities of strength, toughness, dimensions, etc.

(h) The physical and electrical characteristics of the insulation under change of temperature will be tested by exposing the finished conductor for several hours at a time, alternately, to a temperature of 200° F. (dry heat) and the temperature of the atmosphere, during a period of three days.

(i) The tests for characteristics of the insulation will then be repeated and must show no practical deterioration on the results of the former test.

11. *Double conductor*.—Double conductor will be classed as:

(a) Double conductor, plain.

(b) Double conductor, silk.

(c) Double conductor, diving lamp.

12. *Double conductor, plain*.—Each conductor shall be constructed as follows:

First. A copper conductor consisting of seven No. 22 B. & S. G., tinned, annealed, pure copper wires, six of the wires to lay around the seventh. Each single wire to have a measured conductivity of not less than ninety-eight (98) per cent., and the conductor as a whole of not less than ninety-five (95) per cent. of that of pure copper of the same number of circular mils.

One conductor is to be covered with:

First. A layer of vulcanized rubber to an external diameter of one hundred and eighty-one thousandths (.181) of an inch.

Second. With a close braid of No. 60 cotton thread, braided with three ends.

This conductor will form the core and the wires of the second conductor will be laid around it over the braid concentrically and smoothly.

Over both conductors will be:

First. A close braid of No. 60 cotton thread, braided with three ends.

Second. A layer of vulcanized rubber to an external diameter of thirteen thirty-seconds ($\frac{13}{32}$) of an inch, to be vulcanized before braiding.

Third. A layer of commercial cotton tape, about one thirty-second ($\frac{1}{32}$) of an inch in thickness.

Fourth. A close braid of No. 30 2-ply linen gilling thread braided with three ends.

Fifth. A close braid of No. 30 3-ply linen gilling thread braided with three ends.

The fourth and fifth layers of braid to be thoroughly saturated with a water-excluding compound which will not injure the braid or render the conductor less pliable.

13. *Double conductor, silk.*—Each conductor shall be constructed as follows:

First. A stranded copper conductor consisting of seven (7) No. 25 B. & S. G., untinned, annealed copper wires, six wires to lay concentrically around the seventh; each single wire forming the strand to have a measured conductivity of ninety-eight (98) per cent. and the stranded copper conductor ninety-five (95) per cent. of that of pure copper of the same number of circular mils.

Second. A close braid made of No. 80 Sea Island cotton thread.

Third. A layer of pure Para rubber to a diameter of four thirty-seconds ($\frac{4}{32}$) of an inch.

Fourth. A close braid made of No. 60 cotton thread.

Fifth. A close braid made of hard twisted, olive green silk.

Sixth. Two conductors thus constructed shall be twisted together to form the finished conductor.

14. *Double conductor, diving lamp.*—Each conductor shall be constructed as follows:

First. A copper conductor consisting of seven (7) No. 20 B. & S. G., tinned, annealed copper wires, six of the wires to lay around the seventh; each single wire to have a measured conductivity of not less than ninety-eight (98) per cent. and the conductor as a whole of not less than ninety-five (95) per cent. of that of pure copper of the same number of circular mils.

Second. A layer of pure Para rubber, taped or rolled on to a thickness of not less than one sixty-fourth ($\frac{1}{64}$) of an inch; if taped, the tape to lap one-half of its width to a diameter of one hundred and twenty-six thousandths (.126) of an inch.

Third. A layer of vulcanized rubber to an external diameter of one hundred and eighty-six thousandths (.186) of an inch.

Two conductors thus constructed shall then be laid up or twisted together, and filled with jute lateral to a circular section and an external diameter of three hundred and seventy-two thousandths (.372) of an inch. The jute to be saturated with an insulating compound.

Then to be covered with:

First. A layer of vulcanized rubber to a diameter of eighteen thirty-seconds ($\frac{3}{16}$) of an inch.

Second. A close braid of No. 30 3-ply linen gilling thread, braided with three ends.

Third. A close braid of No. 30 3-ply linen gilling thread, braided with four ends.

15. *Tests*.—Unless called for in smaller quantities, all double conductor wire, plain, shall be delivered in lengths of not less than 500 feet; it shall have an insulation resistance between conductors and from each conductor to ground of at least 1000 megohms per 1000 feet after 24 hours' immersion in sea water at 72° F. This insulation must also exist after the whole length has been exposed for four hours to a temperature of 180° F.

16. Double conductor, silk, shall have an insulation resistance between conductors of at least 20 megohms per 1000 feet, tested in air at a temperature of 72° F.

17. Double conductor, diving lamp, shall have an insulation resistance between conductors and from each conductor to ground of at least 1000 megohms per 1000 feet, after 24 hours immersion in sea water at 72° F. This insulation must also exist after the whole length has been exposed for four hours to a temperature of 180° F. (dry heat).

SPECIFICATIONS FOR BELL WIRE.

18. Bell wire will be classed as:

Bell wire.

Bell cord.

BELL WIRE.

19. Bell wire shall be constructed as follows:

First. A copper conductor consisting of one (1) B. & S. G., No. 16, tinned, annealed copper wire whose measured conductivity shall not be less than ninety-eight (98) per cent. of that of pure copper of the same number of circular mils.

Second. A layer of pure Para rubber, taped or rolled on to a thickness of not less than one sixty-fourth ($\frac{1}{64}$) of an inch; if taped, the tape to lap one-half its width.

Third. A layer of vulcanized rubber to a diameter of fourteen hundred and twenty-five ten-thousandths (.1425) of an inch.

Fourth. A layer of commercial cotton tape, about one thirty-second ($\frac{1}{32}$) of an inch in thickness.

Fifth. A close braid of No. 40 2-ply cotton thread, braided with three ends.

Unless called for in smaller lengths all bell wire must be delivered in lengths of not less than five hundred (500) feet.

Tests.—The tests, in addition to ascertaining conformity with the foregoing specifications, will be as follows:

(a) The insulation resistance shall not be less than one thousand (1000) megohms per one thousand (1000) feet, after immersion in sea water at seventy-two (72) degrees F., for a period of twenty-four (24) hours.

(b) The wire will then be subjected alternately, for several hours at a time, for a period of twenty-four (24) hours, to a temperature of one hundred and eighty (180) degrees F. (dry heat) and the temperature of the air.

(c) The insulation will then be tested, after an immersion in sea water at seventy-two (72) degrees F., for a period of twenty-four (24) hours, and must show no variation on the results of the previous test.

BELL CORD.

20. Bell cord will be classed as:

Bell cord, double.

Bell cord, triple.

21. Each conductor will be constructed as follows:

First. A stranded copper conductor consisting of seven (7) No. 25 B. & S. G. untinned, annealed copper wires, six (6) wires to lay concentrically around the seventh; each single wire forming the strand to have a measured conductivity of not less than ninety-eight (98) per cent., and the stranded copper conductor not less than ninety-five (95) per cent. of that of pure copper of the same number of circular mills.

Second. A close braid made of No. 80 Sea Island cotton thread.

Third. A layer of pure Para rubber to a diameter of four thirty-seconds ($\frac{4}{32}$) of an inch.

Fourth. A close braid made of No. 60 cotton thread.

Fifth. A close braid made of hard twisted, olive green silk.

Sixth. Two or three conductors thus constructed will be twisted together to form the bell cord either double or triple as required.

SPECIFICATIONS FOR CABLE.

22. Cable will be classed as follows:

Controller cable.

Interior communication cable.

Whistle cable.

Special cable.

CONTROLLER CABLE.

23. Each conductor shall be constructed as follows:

First. A copper conductor consisting of nineteen (19) No. 22 B. & S. G. tinned, annealed, pure copper wires, concentrically stranded. Each single wire to have a measured conductivity of not less than ninety-eight (98) per cent., and the conductor, as a whole, not less than ninety-five (95) per cent. of that of pure copper of the same number of circular mills.

Second. A layer of pure Para rubber taped or rolled on to a thickness of not less than one sixty-fourth ($\frac{1}{64}$) of an inch.

Third. A layer of vulcanized rubber to an external diameter of twenty-eight thousand one hundred and thirty-one hundred-thousandths (.28131) ($\frac{9}{32}$) of an inch.

Seven conductors so constructed shall be laid up or twisted together to a circular section, six conductors to lay around the seventh to an external diameter of eighty-four hundred and thirty-eight ten-thousandths (.8438) ($\frac{33}{40}$) of an inch.

Then to be covered with:

First. A layer of vulcanized rubber to an external diameter of ninety-six hundred and eighty-eight ten-thousandths (.9688) ($\frac{11}{16}$) of an inch.

Second. A layer of commercial cotton tape about one thirty-second ($\frac{1}{32}$) of an inch in thickness.

Third. A close braid of No. 30 3-ply linen gilling thread, braided with three ends.

Fourth. A close braid of No. 30 3-ply linen gilling thread, braided with four ends, to a finished diameter of one and one-eighth ($1\frac{1}{8}$) inches.

24. Controller cable shall be furnished in lengths of twenty-five (25) feet, each length to be fitted at each end with a thoroughly water-tight male coupling, the coupling to be in exact conformity with the design approved by the Bureau.

25. Controller cable and couplings must show an insulation resistance between conductors and from each conductor to ground of not less than one (1) megohm after immersion in sea water at a temperature of seventy-two (72°) degrees F. for a period of twenty-four hours.

INTERIOR COMMUNICATION CABLE.

26. This cable shall contain from two to twenty separate conductors, as may be required.

The unit conductor of each cable shall be constructed in conformity with the specifications for bell wire, except that no tape or braid shall be put on; the layer of vulcanized rubber must be of an external diameter of fourteen hundred and twenty-five ten-thousandths (.1425) of an inch.

Each cable is then to be constructed as follows:

The requisite number of unit conductors for each type of cable is to be laid up or twisted together and filled with jute laterals to a circular section, the lay and filling to conform to the designs approved by the Bureau January, 1897.

Then to be covered with:

First. A layer of commercial cotton tape about one thirty-second ($\frac{1}{32}$) of an inch in thickness.

Second. A layer of vulcanized rubber, to be of circular section, and to have a smooth surface in the finished cable and an external diameter in exact conformity with that set forth in the table following.

Third. A layer of commercial cotton tape about one thirty-second ($\frac{1}{32}$) of an inch in thickness.

Fourth. A close braid of No. 20 2-ply cotton thread, braided with three ends, for all cables of less than twelve (12) conductors, and of No. 16 3-ply cotton thread, braided with four ends, for all cable of and above

twelve (12) conductors. The finished diameter must be in exact conformity with that set forth in the table following.

Fifth. One unit conductor in each lay of the cable must be braided with No. 60 cotton thread. This braid to be white and not to be filled with any compound that will affect its color.

27. The following table contains the prescribed dimensions of the standard cables, in accordance with the specified construction of the Bureau's designs above mentioned, No. 825 A, Equipment Department, Navy Yard, New York.

DIMENSIONS OF STANDARD INTERIOR COMMUNICATION CABLE.

Conductors.	Diameter in inches.		Diameter in $\frac{1}{32}$ of an inch.		
	Over Conductors.	Over Tape.	Over vulc. rubber.	Over Tape.	Over Braid.
2 .....	.285	.348	16	18	21
3 .....	.307	.370	17	19	22
4 .....	.344	.406	18	20	23
5 .....	.385	.447	20	22	25
6 .....	.428	.490	21	23	26
7 .....	.428	.490	21	23	26
8 .....	.471	.533	22	24	27
9 .....	.515	.577	24	26	29
10 .....	.559	.622	25	27	30
11 .....	.570	.633	26	28	31
12 .....	.592	.655	26	28	31
13 .....	.604	.666	27	29	32
14 .....	.629	.691	27	29	32
15 .....	.648	.711	28	30	33
16 .....	.670	.732	29	31	34
17 .....	.693	.756	29	31	34
18 .....	.713	.775	30	32	35
19 .....	.713	.775	30	32	35
20 .....	.738	.800	31	33	36

UNIT CONDUCTOR.

Wire Number.	C. M.	Diameter in inches.		
		Over copper.	Over Para rubber.	Over vulc. rubber.
16	2,583	.05082	.081	.1425

Unless called for in smaller lengths, all interior communication cable must be delivered in lengths of not less than five hundred (500) feet.

28. *Tests.*—The tests, in addition to ascertaining conformity with the foregoing specifications, will be as follows:

(a) The insulation resistance between conductors and from conductors to ground shall not be less than one thousand (1,000) megohms per one

thousand (1,000) feet, after immersion in sea water at seventy-two (72°) degrees F. for a period of twenty-four (24) hours.

(b) The finished cable will then be subjected alternately, for several hours at a time, for a period of twenty-four (24) hours, to a temperature of one hundred and eighty (180°) degrees F. (dry heat) and the temperature of the air.

(c) The insulation will then be tested, after an immersion in sea water at seventy-two (72°) degrees F. for a period of twenty-four (24) hours, and must show no variation on the results of the previous tests.

WHISTLE CABLE.

29. Whistle cable will be classed as:

Double conductor.

Triple conductor.

WHISTLE CABLE, DOUBLE CONDUCTOR.

30. Each conductor shall be constructed as follows:

First. A copper conductor consisting of seven (7) No. 22 B. & S. G. tinned, annealed copper wires, six of the wires to lay around the seventh; each single wire to have a measured conductivity of not less than ninety-eight (98) per cent. and the conductor as a whole of not less than ninety-five (95) per cent. of that of pure copper of the same number of circular mils.

Second. A layer of pure Para rubber, taped or rolled on to a thickness of not less than one sixty-fourth ($\frac{1}{64}$) of an inch; if taped, the tape to lap one-half its width to a diameter of one hundred and six thousandths (.106) of an inch.

Third. A layer of vulcanized rubber to an external diameter of two hundred and forty-six thousandths (.246) of an inch.

Two conductors so constructed are to be laid or twisted together and filled with jute laterals saturated with an insulating compound to a circular section and an external diameter of four hundred and ninety-two thousandths (.492) of an inch.

Then to be covered with:

First. A layer of commercial cotton tape to a diameter of five hundred and fifty-two thousandths (.552) of an inch.

Second. A layer of vulcanized rubber to a diameter of twenty-one thirty-seconds ($\frac{1}{16}$) of an inch.

Third. A close braid of No. 30 3-ply linen gilling thread braided with four (4) ends, to a finished diameter of eight hundred and thirty-two thousandths (.832) of an inch.

WHISTLE CABLE, TRIPLE CONDUCTOR.

31. Each conductor shall be constructed as follows:

First. A copper conductor consisting of seven (7) No. 22 B. & S. G. tinned, annealed copper wires, six of the wires to lay around the seventh; each single wire to have a measured conductivity of not less than ninety-

eight (98) per cent. and the conductor as a whole of not less than ninety-five (95) per cent. of that of pure copper of the same number of circular mills.

Second. A layer of pure Para rubber, taped or rolled on to a thickness of not less than one-sixty-fourth ($\frac{1}{64}$) of an inch; if taped, the tape to lap one-half its width, to a diameter of one hundred and six thousandths (.106) of an inch.

Third. A layer of vulcanized rubber to an external diameter of two hundred and six thousandths (.206) of an inch.

Three conductors so constructed are to be laid or twisted together and filled with jute laterals saturated with an insulating compound to a circular section and an external diameter of four hundred and forty-three thousandths (.443) of an inch.

Then to be covered with:

First. A layer of commercial cotton tape to a diameter of five hundred and three thousandths (.503) of an inch.

Second. A layer of vulcanized rubber to a diameter of twenty-one thirty-seconds ($\frac{1}{16}$) of an inch.

Third. A close braid of No. 30, 3-ply linen gilling thread, braided with three ends.

Fourth. A close braid of No. 30, 3-ply linen gilling thread, braided with four ends, to a finished diameter of eight hundred and thirty-three thousandths (.833) of an inch.

Unless called for in smaller quantities, all whistle cable must be delivered in lengths of not less than 500 feet.

32. *Tests.*—The tests, in addition to ascertaining conformity with the foregoing specifications, will be as follows:

(a) The insulation resistance between conductors and from conductors to ground shall not be less than 5000 megohms per 1000 feet after immersion in sea water at 72° F., for a period of 24 hours.

(b) The finished cable will then be subjected alternately for several hours at a time, for a period of 24 hours, to a temperature of 200° F. (dry heat) and the temperature of the air.

(c) The insulation resistance will then be tested, after an immersion in sea water at 72° F., for a period of 24 hours, and must show no variation on the results of the previous test.

SPECIAL CABLE FOR ENGINE TELEGRAPH (FISKE).

33. The transmitter and receiver shall be connected by a cable of two 30,000 cm. (30,858 cm. actual) standard lighting wires, except that they shall not be covered with tape or braid.

Two such wires will be laid up or twisted together with jute laterals saturated with an insulating compound to a circular section and an external diameter of $\frac{3}{4}$ of an inch.

Then to be covered with:

First. A layer of commercial cotton tape about $\frac{1}{4}$ of an inch in thickness.

Second. A layer of vulcanized rubber to an external diameter of $\frac{3}{4}$ of an inch.

Third. A layer of commercial cotton tape about $\frac{1}{4}$ of an inch in thickness.

Fourth. A close braid of No. 20, 2-ply cotton thread, braided with three ends to a finished diameter of $1\frac{1}{8}$ inches.

SPECIAL CABLE FOR RANGE FINDER (FISKE).

34. The connections for the range finder shall be run by cable of the following construction:

The conductors shall consist of three (3) 20,000 cm. (22,799 cm. actual) standard lighting wires, and one (1) standard bell wire, except that they shall not be covered with tape or braid.

The four wires so constructed shall be laid or twisted together with jute laterals, saturated with an insulating compound, to a circular section and an external diameter of twenty-eight thirty-seconds ($\frac{1}{11}$) of an inch, the three large conductors to lay around the bell wire.

Then to be covered with:

First. A layer of commercial cotton tape about one thirty-second ($\frac{1}{32}$) of an inch in thickness.

Second. A layer of vulcanized rubber to an external diameter of one and one-sixteenth ($1\frac{1}{16}$) inches.

Third. A close braid of No. 16, 2-ply cotton thread to a finished diameter of one and one-eighth ($1\frac{1}{8}$) inches.

PERMANENT AND MOVABLE ELECTRIC LIGHT FIXTURES.

PERMANENT ELECTRIC LIGHT FIXTURES.

1. The standard permanent fixtures are:

- Bulkhead.
- Bunker.
- Ceiling Nos. 1, 2, 3.
- Steam tight.
- Bracket (single or double).
- Double truck.
- Binnacle light.

MOVABLE ELECTRIC LIGHT FIXTURES.

2. The standard movable fixtures are:

- Desk light.
- Running lights (masthead and side).
- Towing light.
- Top-light.
- Stay light.
- Magazine lantern.
- Signal lantern (white, green or red).
- Battle lantern.
- Deck lantern.
- Portable.
- Cargo reflector.

Navigator's lantern.

Diving lantern.

Telegraph light.

3. All the foregoing fixtures and lights must conform strictly to the Bureau's designs, blue prints of which can be had on application to the Bureau or to the Equipment Department, New York Navy Yard.

ELECTROLIERS.

4. Electroliers are to be of commercial types, finished in silver or dark bronze or as directed.

5. Those for torpedo-boats will combine two electric lights with a lamp of hurricane type. Electroliers will be supplied, wired and fitted with shades and key sockets; the shades and sockets to be of standard pattern.

6. Electroliers to be fitted with four stay chains of same finish as the fixture.

PERMANENT FIXTURES.

7. *Bulkhead* and *steam-tight* fixtures will be finished in dark bronze. To be supplied with globe, mounting block and socket, of standard pattern.

8. *Ceiling fixtures No. 1, No. 2 and No. 3* are intended for general use. The No. 3 to be used as electroliers. All to be finished in oxidized silver or dark bronze or as directed; each to be supplied with globe, mounting block and socket of standard pattern.

9. *Commercial ceiling fixture* of same design as *desk-light* shade-holder, but fitted to a base similar to that of the *single bracket*; to be supplied with shade, mounting block and key socket of standard pattern; to be finished in silver or dark bronze or as directed.

10. *Brackets* to be finished in silver or dark bronze or as directed; to be fitted with shade, mounting block and key socket of standard pattern.

MOVABLE FIXTURES.

11. All shades, shade-holders, globes, sockets and gaskets shall be those of the Bureau's standard patterns and designs.

12. *Desk lights*, intended for use in offices and staterooms, will be finished in either silver plate or dark bronze or as directed. All desk lights to be fitted with shade-holder, shade and key socket of same finish.

13. *Running lights*, finished in dark bronze, fitted for two lamps; the *masthead* type to be used for *towing light* and *top light*; *side lights* to be in pairs, one starboard and one port; the colored shades for side and signal lights to be of an approved depth of color, and to be subject to a test for color at the Navy Yard, New York. Running lights, towing and top lights to be fitted with two keyless bronze sockets and two D. 13 gaskets.

14. *Magazine lantern*, finished in dark bronze and fitted for two lamps and reflectors, to show light on four sides. A seat will be provided for regulation magazine candlestick.

15. *Signal lantern*, finished in dark bronze, intended for signal purposes. All signal lanterns to be fitted with keyless bronze socket and D. 13 gasket.

16. *Deck lantern*, finished in dark bronze and intended for general use. It can be used with or without any of its parts, i. e. wire guard or steam-tight globe.

17. *Battle lantern* to be similar to deck lantern, but to have in addition metal shield with slide for the purpose of shutting off the light at the side.

18. All deck and battle lanterns to be fitted with steam-tight globe, keyless bronze socket and D. 13 gaskets.

19. *Portable*, finished in dark bronze. All portables to be fitted with keyless bronze socket and D. 13 gasket.

20. *Cargo reflector*, finished on the outside of reflector in dark bronze; inside in white enamel; to be fitted with four bronze keyless sockets and D. 13 gasket.

21. *Navigator's lantern*, finished in dark bronze, to be fitted with bronze key socket and D. 13 gasket.

22. *Diving lantern*, polished brass finish, to be fitted with bronze key socket and two C. 18 gaskets.

23. *Telegraph light*, for lighting mechanical telegraphs, finished in dark bronze, to be fitted with standard instrument light socket, rectangular base, and D. 13 gasket.

SHADES AND GLOBES.

24. *Shades*.—Shades to be $3\frac{1}{4}$ inches in diameter at holder, 6 inches wide at mouth, and 4 inches deep; mouth to have 12 flutes; to be of the best opal glass.

25. *Globes*.—All globes to be the best quality of flint glass; those specified to be ground will be ground on the inside only, and sufficiently to soften the light but not to cut it off to any great extent.

26. *Steam-tight globes*.—Steam-tight globes to be of clear glass, not more than $\frac{1}{4}$ inch thick nor less than $\frac{1}{8}$ inch thick; outside length, 8 inches; outside diameter, $3\frac{1}{8}$ inches.

27. *Globes for ceiling fixtures*.—Globes for C. F. No. 1 to be of ground glass, 5 inches in diameter and 6 inches deep; to be not more than $\frac{3}{8}$ inch nor less than $\frac{1}{8}$ inch thick; to secure to the metal collar of the fixture by means of a coarse screw thread, 4 to the inch. Globes for C. F. No. 2 and No. 3 to be either ground or clear, as directed, not more than $\frac{1}{4}$ inch nor less than $\frac{1}{8}$ inch thick; diameter inside, $7\frac{1}{4}$ inches; depth inside, $3\frac{1}{8}$ inches. To secure to the metal collar of the fixture by means of a coarse screw thread, 4 to the inch.

LENSES.

28. Lenses for running lights to be French Fresnel lenses, the separate pieces to be cut, polished and set in a metal frame. For signal lantern the pressed lens, carefully polished, will be allowed.

29. All fixtures, lights and accessories to be of the best quality and workmanship; the plating and bronzing to be of the most durable kind and sufficiently heavy to withstand the action of salt water, and shall be subject to test as to the fulfillment of these specifications, at the New York Navy Yard, or as directed.

ACCESSORIES AND INSTRUMENTS.

SWITCHBOARD.

1. The design of switchboard in general to be such that any number of dynamos may run singly on the lighting, search-light or motor circuits, or any combination of them in parallel; and any combination of the number of the dynamos may run in multiple on any of the circuits, or any combination of them in parallel.

2. The switchboard to consist of a switchboard proper and two instrument boards, the bases of all to be made of slate or marble of uniform thickness, not less than 1 inch. If slate is used it will be finished with black enamel on all sides.

3. The switchboard proper shall have two common positive bars and as many double negative bars as there are dynamos used in connection with it.

4. The material of the bars to be of copper of high conductivity, the size to be ample for any capacity that may be demanded of them.

5. Allowance to be made in securing the bars to the board to insure against detrimental effects from expansion.

6. Both positive and negative bars shall be permanently connected at the back of the board, and each shall have as many terminals as there are dynamos.

7. There shall be a double-pole switch, of all-drawn pure copper, for each dynamo, connecting the terminals of the equalizing wire and of the negative bus bars with a common equalizer and a common negative bar.

8. The circuits to terminate at the back of the board; conical copper thimbles to be provided for capping the ends of the feeders; the thimbles to fit in conical holes on the back of the board and to be secured by screws.

9. The positive leg to be connected by a single switch to the positive bus bar, and the negative leg by a double-throw shifting switch, by which current is taken from the negative bus bar.

10. The circuit switches to carry 150 amperes unless otherwise directed; the negative bus bars to carry the maximum capacity of their dynamos; the positive bus bars to carry the maximum capacity of all the dynamos connected to either leg. There must be a spring clip fuse between each terminal and corresponding bus bar.

11. Name plates shall be furnished showing the serial number of each circuit, the character and location of its load.

12. The name plates to be placed adjacent to their respective switches and fuses.

13. A name plate is to be furnished showing the name of the vessel to which the switchboard is to be supplied.

14. Each negative bus bar shall have at its upper end a number corresponding to the number of the generating set with which it is connected.

15. The instrument boards will be 12 inches in width and of the same length and thickness as the switchboard proper.

16. The left-hand instrument board to be provided with a voltmeter

for each generating set; the connections to be made directly to the dynamic terminals.

17. The right-hand board to be provided with as many direct-reading ammeters as there are generating sets.

18. A separate board to be provided with a separate voltmeter and ammeter for each search-light installed, the instruments for each circuit to be mounted one above the other, the voltmeters uppermost.

19. Ammeters and voltmeters for the generating sets to be marked with the number of the set; ammeters and voltmeters for search-light circuits to be marked with the name and number of the particular light.

20. The shunt rheostats to be mounted on a separate panel of similar material to that of the switchboard; to be placed in regular order and marked with numbers corresponding to those of the generating sets.

FIELD RHEOSTATS.

21. Field rheostats are to be constructed with reference to the particular service required of their generating sets, and shall contain no combustible or absorbent material.

22. They must be as compact as possible, be well ventilated, have sufficient range to compensate for the increased resistance of the field coils due to heating, and have the contact points so arranged that the resistance of the field coils can be varied by small amounts.

23. The material of the coils must be such as will resist oxidation and will insure that heating will not affect the constituent metals of its alloy.

24. Each rheostat shall be marked with the factory number, the number corresponding to the generating set with which it is used, and also with the words "high" and "low," to indicate the direction of the motion of the handle required for increased or decreased voltage.

25. Rheostats must be of approved design, construction and operation.

GAUGES.

26. All gauges to have a $5\frac{1}{2}$ -inch dial, with single Bourdon spring Union steam-gauge cocks and solid-drawn seamless tube.

27. Steam gauges to be graduated for 0 to 160 pounds inclusive. Vacuum gauges to be compound pressure, and vacuum gauges graduated for 30 inches vacuum and 40 pounds steam.

28. Gauges to be finished in nickel plate.

CYLINDER LUBRICATORS.

29. Cylinder lubricators to be of half-pint or pint capacity, as directed.

30. To be double-connection automatic sight feed, for stationary engines, and of standard pattern.

31. The construction to comprise: Oil reservoir; oil filter; water-feed valve; valve to regulate flow of oil; steam tube and condensing chamber; drain valve to draw off water, sight feed glass; indicator glass; oil-discharge pipe; valve to correct pulsation and unsteadiness of feed vent.

32. Each to be supplied with a copy of directions for use and two extra sets of glasses and washers.

33. The finish to be nickel plate.

AMMETERS AND VOLTMETERS.

34. To be of the movable coil type; those for use on switchboard or with search-lights to be circular; to be direct reading, and deadbeat without mechanical damper. The scales to be evenly divided over the entire range, beginning at zero. To have no magnetic lag. The temperature correction to be a minimum. The heating effect to be negligible. The parts to be made to gauge and strictly interchangeable.

35. The stops must arrest the motion at the coil and not at the pointer.

36. The scale must be varnished and thoroughly cemented to the support. The pointers to be well balanced and very narrow in the direction of the plane of the scale.

37. Scales for switchboard and search-light voltmeters must read to 125 volts inclusive.

38. Scales for switchboard and search-light ammeters must read to 50 per cent. above the rated load of dynamo or search-lights.

39. Switchboard and search-light ammeters and voltmeters to have water-tight cases, with a special compartment for circuit connections inside the case; the ammeters to be of the shunt type, the shunts to be contained in special water-tight metal cases; the voltmeters to be fitted with a normal index.

40. Portable ammeters must have a scale to 150 inclusive, and be supplied in a carrying case of varnished hard wood.

41. Portable voltmeters must have 15 and 150 scales, and be supplied in a carrying case of varnished hard wood.

TACHOMETER AND COUNTER.

42. Portable hand tachometers are to be furnished in morocco cases.

43. The scales to be graduated from 100 to 1,000 revolutions.

44. Each tachometer to be supplied with two sets of gear wheels, by which speeds of 50 to 500 and 200 to 2,000 may be indicated.

45. Hand counters are to be furnished in morocco cases; to be of an approved type.

46. Tachometers and counters are to be finished in nickel plate.

TESTING SETS AND GENERATORS.

47. Portable testing sets are to comprise a Wheatstone bridge, rheostat galvanometer, battery and keys, in polished mahogany cases.

48. The bridge coils to be of 1—10—100 and 10—100—1,000 ohms with reversing arm plug switch.

49. The rheostat coils to be of 1—2—2—5—10—20—20—50—100—200—200—500—1,000—2,000—2,000—5,000 ohms. The coils to be of platinoid, and to be accurate to within one-fifth of 1 per cent.

50. The galvanometer to be of D'Arsonval pointer type, and to have a sensibility of not less than one division, with one Leclanche cell, through 100,000 ohms in circuit.

51. The battery to consist of six chloride of silver cells, with suitable selecting cords admitting of connections to any two in the three sets.

Motor.

65. The motor to be series wound for 80 volts, four pole, four field coils; armature to be slotted ring; series wound with the cross connections back of the commutator.
66. The brushes to be carbon, copper plated, end feed at angle to radius.
67. The brush holders to be provided with facilities for adjustment and for securing in proper position.
68. The headboard to have binding posts connecting to the line wires and the junction between the field and armature windings.
69. The construction to be such as will prevent any accidental contact with this connection by line wires.

Heating.

70. The journal is to run cool.
71. The maximum increase of the temperature of the windings of both the field and armature shall not be more than 70° F. over that of the surrounding air, measured by increase of resistance method when run on free inlet and outlet.
72. The motor shall not be ventilated through the fan.

Lubrication.

73. The journal is to be efficiently lubricated by a sight feed oil cup of sufficient capacity for an 8-hour run, which is to be located on the top of the motor frame and connected to the journal by a feed tube.
74. The ends of the support to journal bushing are to be provided with extensions and channels adapted to catch the expended oil and conduct it through a tube to a receptacle at the bottom of the set which is to be provided with a drip cock for emptying as required.

Insulation.

75. No insulating material that can be injured by moisture or a temperature of 200° F. shall be used.
76. All the turns, windings and cross connections to be coated with an approved insulating varnish as wound on or put in place.
77. The completed field coils and armature shall be thoroughly covered, to exclude oil moisture.
78. The insulation resistance between the conductors of the connected machine and frame shall not be less than 1 megohm, measured with not over 1,000 volts before and after test.
79. To be furnished with six extra set brushes, two extra oil-cup glasses, one extra set brush-holder springs, two 25-foot lengths canvas hose fitted with couplings, to attach together or to either the inlet or outlet of the exhauster.
80. To be supplied in a painted, hard-wood, strongly-made, tightly-fitted, screw-fastened box with brass hinges, lock and transporting handles. Chocks to be fitted and secured to keep the set in place when transported. The spare parts to be fitted in separate divisions in upper part of box.

DESK AND BRACKET FANS.

Desk Fans.

40. Desk fans will be one-eighth H. P. capacity and wound for 110 volts, to be fitted with a 4-bladed fan 16 inches diameter.
41. The fan to be starting and regulating switch in the base and rheostat in the control giving three speeds at a voltage of about 1,500, 1,200 and 800.
42. The bearings to be self-oiling and self-aligning; to operate without lubricating or packing of oil.
43. All outside brass fittings to be polished.
44. The finish, including fan and guard to be black japanned. The base to be provided with three rubber washers, to deaden vibration and prevent rattage.
45. The armature to be slotted from. The field and armature to be satisfactorily protected from the access of moisture, oil and dirt. The brushes to be carbon with end feed. The insulation resistance to be not less than 1 megohm, measured with not more than 500 volts.
46. The operation to be with a minimum of noise, friction and vibration.
47. The serial factory number and maker's name to be on a name plate.
48. Each set will be supplied with an extra set of brushes for each fan.

Bracket Fans.

49. Bracket fans are to have a rated capacity of one-sixth H. P., to be wound for 110 volts, and to be fitted with a 4-bladed fan 16 inches in diameter.
50. The specifications for finish, switch and rheostat, bearings, fittings, fan, guard, base, armature, protection of armature and field, brushes, insulation resistance, operation, name plate and spare brushes will be the same as those prescribed for the 12-inch desk fan.
51. The base to be constructed for securing against a bulkhead.
52. The motor and fan to be so mounted that the direction of the air current can be varied. The speeds to be about 1,500, 1,200 and 800.

RHEOSTATS FOR MOTORS.

53. To be of four types: (a) Starting; (b) regulating; (c) regulating and reversing; (d) special, to be as directed.
54. All are to be provided with an automatic circuit breaker to protect the armature in the case of overload, or failure to open the circuit at the rheostat.
55. Unless otherwise directed: (a) The resistance on the first point shall be such that 80 per cent. of the line voltage shall be dropped in the rheostat with the current of the rated capacity; (b) the device shall open the circuit at 50 per cent. over load.
56. The capacity is to be obtained without paralleling of coils, unless are capable of carrying the full-line voltage.
- Starting rheostats shall be capable of carrying safely the full-rated I for 15 seconds.

99. Regulating and reversing rheostats shall be of such resistance and capacity as shall be directed. Reversing rheostats shall reverse the armature current only. Regulating rheostats shall be used in all cases for ventilating sets.

100. The construction throughout shall be fireproof. All springs to be of phosphor-bronze and to carry no current. All slate to be black enameled over the entire surface to prevent absorption of moisture. All windings of cut-out magnet coils to be run through an approved insulating varnish as it is wound on. The outside of the coils to be well varnished and taped. No combustible or absorbent material to be used.

101. The terminals shall be marked with a designing letter or number. The factory number and capacity of the rheostat to be plainly marked. The contact points to be ample in size and well fitted on surfaces.

102. The circuit to be opened by a quick uncontrolled movement for the larger sizes. Where the current is of sufficient power to necessitate it, the makes and breaks shall be made on auxiliary points. When so directed the entire rheostat and contacts, excepting the lever, shall be enclosed in a water-tight fire-proof case. In this case the lever is to be provided with marks indicating the different positions of control. The insulation resistances to be not less than 1 megohm.

103. All rheostats to be of approved design, construction and operation.

ELECTRIC OPERATORS FOR STEAM WHISTLES AND SIRENS.

104. To consist of: A valve operated by an electromagnet and also by hand; a clockwork mechanism by which a contact is kept closed automatically for 6 seconds in every minute; a switch by which the valve is controlled from the bridge.

105. The base of the valve chamber is to be a composition casting flanged to $6\frac{3}{8}$ inches, to make a flange joint with $2\frac{1}{2}$ -inch iron pipe size pipe. The main valve is to be operated by an auxiliary valve, which is in turn operated by the armature of the magnet; the hand-control lever to operate directly on the spindle of the main valve.

106. The lever is to be mounted and supplied with a phosphor-bronze retracting-spring guide pulley, with clamp for securing to the steam pipe. A turned and polished mahogany handle is to be supplied for the chain. The lever and handle are to be provided with shackles for attaching the chain.

107. The magnet is to be placed in a water-tight metal case. The coils shall be multiple wound, so that the self-inductive discharge shall be minimized. A device for absorbing the inductive discharge shall be provided and located at the terminals in the magnet case. The magnet is to be so designed that the maximum increase in temperature over the surrounding air shall not be over 70° F., measured by the electrical method. The wire is to be run through an approved insulating varnish as it is wound on. The exterior of the coils is to be well varnished and covered. The connection to the circuit is to be made in a cable coupling case in which the conduit terminates. The terminals of the coil are to be well secured, and with a considerable length of surface insulation.

108. The clockwork mechanism is to be mounted in a metal case with hinged lock cover. The clockwork is to be an 8-day movement with all parts of non-oxidizable metal. Means are to be provided for the visual indication of the operation of the clockwork and for starting. The contact points to be of platinum and of ample size for extended service without renewal, and to give a double-pole break. A separate double-pole contact device shall be provided in the case, so that the apparatus can be controlled in the chart-house.

109. The controlling switch for the bridge shall be of water-tight construction. To be adapted for mounting on a bulkhead or bridge rail. The movement of the lever to the first point to give a closed circuit for a continuous or at-will blast. The secured point to be in a series with the automatic contact which is operated by the clockwork. Means for retaining the switch on this point are to be provided. The entire mechanism of the controlling switch is to be mounted on one base; the functions of the points to be indicated.

110. The tests will be made for normal operation at 80 volts, and 160 pounds steam. The construction and fixed adjustment shall also be such that the operation shall be efficient and the parts shall withstand, without detriment, an operation at 60 and 100 volts, and 50 and 300 pounds steam and water pressures.

111. All terminals to be marked with a designating letter or number. Each outfit to be supplied with: One set spare springs for clockwork; one extra key for case; ten feet brass flat-link chain for hand operation; one copy instructions for care and operation; one copy of diagram of connections.

112. All to be of approved design, construction and operation.

ANNUNCIATORS.

113. Annunciators to be of two types: Water-tight and nonwater-tight.

Annunciators (Water-tight).

114. To be of the drop type. Cases to be of composition, polished on the outside. Covers to be made water-tight by flat 2-ply cloth-insertion rubber gaskets, secured by 6-32 F. H. machine screws. Special provision is to be made for clamping down the hinged side in addition to the other sides, the clamping to be effected by swinging screws and butterfly nuts; the ends of the screws to be split and spread to prevent the nut from working loose. The flange is to be flush with the back.

115. The stuffing tubes to be furnished separately, with gaskets, and to be the standards shown in the Bureau's designs.

116. The magnet coils to be wound with single cotton-covered copper-magnet wire, the wire to be run through an approved insulating varnish as it is wound on.

117. The outer surface of coils to be well varnished before being covered.

118. The magnet heads to be of hard rubber.

119. The drop mechanism to be of such design and construction as to effectually prevent the drops from operating when exposed to the motion

of the vessel or external mechanical shock or jar, particularly that of heavy guns.

120. All wooden interior parts to be well soaked in oil, and varnished before being secured in place.

121. The springs to be phosphor-bronze.

122. All interior metal parts to be nickel plated.

123. The drops to be reset by a plunger operating through the bottom of the case through a water-tight stuffing tube.

124. Each annunciator to be provided with a 3-inch water-tight bell of standard pattern.

Annunciators (Nonwater-tight).

125. Cases to be of solid polished mahogany. All interior wooden surfaces to be oiled and varnished.

126. The drop mechanism and magnet coils to be the same as that specified for annunciators, water-tight.

127. Each to be provided with one iron-box buzzer of standard pattern.

128. Annunciators for fire alarms will have in addition a separate board with push connections for making or breaking each circuit running to the board.

129. Large annunciators will be provided with a ledge underneath the outer hinged part to support the weight when open.

BELLS.

130. Bells to be water-tight or nonwater-tight as directed, and of two kinds: Vibrating bells; single-stroke bells.

131. All bells directed to be water-tight must conform strictly to the Bureau's designs; the sizes to be designated by the diameter of the gong.

Vibrating Bells.

132. Water-tight vibrating bells are to be in two sizes, 3-inch and 6-inch, as may be required.

133. Nonwater-tight vibrating bells to be of commercial iron-box type; to be in two sizes, 2½ inches and 5 inches, as may be required; the cover to be secured by a lug fitting under a recess on the gong side, and a snap spring on the opposite side; the spring and lug to insure that the cover will not fall off under mechanical shock or jar. To have pivoted armature and non-turning binding posts; to ring easily on one Leclanche cell and be adjustable to ring on an increased number of cells.

Single-stroke Bells.

134. Water-tight single-stroke bells to be 6-inch, and of same pattern as the water-tight vibrating bell.

135. Nonwater-tight single-stroke bells to be of commercial iron-box 5-inch type, and of the same pattern as the nonwater-tight vibrating bell; to have non-turning binding posts and ring easily on one Leclanche cell and be adjustable to ring on an increased number of cells.

Buzzers.

136. Buzzers to be water-tight and nonwater-tight, as directed.

137. Water-tight buzzers will conform strictly to the Bureau's design,

all contacts to be of platinum. Bosses for screws to be flush with the back of the case. All wire of windings to be run through an approved insulating varnish as it is wound on; the windings to be varnished before covering is put on. Joints to be rosin soldered and taped.

138. Nonwater-tight buzzers are to be of the iron-box type; the case, mechanism and cover to conform to the specifications for the 2½-inch water-tight bell. All contacts to be of platinum. The outside of the coils to be well varnished or shellaced before covering.

139. All buzzers to ring easily on one Leclanche cell and be adjustable to ring on an increased number of cells.

CEILING BUTTONS.

140. Ceiling buttons to be of commercial porcelain type, 1½ inch in diameter.

141. The interior of the base to be conical, to have a central hole for the wire lead not less than five-sixteenths of an inch in diameter; to be provided with two screw holes for securing to the woodwork, and two scores in the rim for leading in the wires.

THERMOSTATS.

142. Thermostats will be of the mercurial type; the mercury to be strained and pure.

143. The contact to be made in an enclosed air-tight chamber.

144. The increase of temperature necessary for efficient operation must have no detrimental effect on the efficiency, operation or construction of the device.

145. To be non-adjustable; the insulating material to be of such a nature or so treated as to prevent the absorption of moisture, in order to prevent grounding or short-circuiting.

146. The chamber to be arched in its upper part in order that the mercury may have free access to the contact point; the chamber surrounding the contact point to be of a reduced cross section.

147. The supporting and containing flange to be as light as possible and to touch in three small surfaces only, so that there may be a minimum conduction of heat from the mercury. The diameter of the flange to be 1⅞ inch, with two five thirty-seconds inch holes on a diameter; distance to be 1½ inch center to center. The body to be not over 1⅞ inch diameter, and 1⅞ inch high over head of screw.

148. Thermostats are to be tested by suspending them in dry air, steam-coil heated. They must close the circuit at not less than 200° nor more than 220° F., and not require more than ten minutes to do so.

TELEGRAPHS AND INDICATORS.

149. The connecting points for all telegraphs and indicators are to be distinctly marked with a designating number, to facilitate connections and avoid danger of burning out.

Engine Revolution-order Telegraphs.

150. Engine revolution-order telegraphs are to be as compact as possible, that they may be installed in conning towers.

151. The part of the device intended for use on the bridge (or in chart-house or conning tower) to consist of a transmitter and reply receiver; the scale to indicate each revolution, unless otherwise directed, and be capable of indicating each individual point of the scale within the assigned limits.

152. The motion of the handle or lever is to be in the same direction as the desired motion of the vessel unless impracticable from the principle of operation of the instrument; any motion of the handle in either direction must operate a distinctly audible signal in the engine-room.

153. The construction of the instrument to be such that it can be mounted on a column. In twin-screw vessels it is very desirable that the instruments for both engine-rooms shall be combined in order to secure convenience of operation and simultaneous transmission to both engines.

154. The instruments that are to be placed in the engine-room to consist of a receiver and a reply transmitter, the dials to correspond to those of the instruments on deck.

155. The direction of the motion of the handle or lever of the reply transmitter to be in the same direction as the motion of the vessel indicated by the deck order, unless impracticable from the principle of operation of the instrument.

156. The construction of the instrument to be adapted for mounting on bulkheads; in twin-screw vessels to be mounted on the longitudinal bulkhead.

157. All transmitters, reply transmitters, receivers or reply receivers must be thoroughly water-tight; their dials to be illuminated by standard instrument lamps; the handles or levers to be capable of being secured or removed when the instruments are not in use.

158. The design of engine revolution-order telegraph devices must be such that they will operate efficiently irrespective of ordinary variations of circuit potential.

159. All engine revolution-order telegraphs, connections and instruments to be of approved design, construction and operation.

Helm-order Telegraphs.

160. Helm-order telegraphs are to be of the simplest possible construction; to be of such material and construction as to be unaffected by moisture and capable of being operated on deck in any weather. They are to be adapted for mounting on a pedestal or a bulkhead as may be required. The actuating force is to be of sufficient magnitude to prevent inaccuracy of indication from ordinary changes in contact resistances. The dials to be direct reading to the extent of showing all convenient and necessary angles of helm for tactical use. The dials to be water-tight; the mechanism to be so constructed that the indications will not be materially affected by ordinary fluctuations of circuit potential; the dials to be illuminated by standard instrument lamps.

161. The movement of the handle, lever or pointer to correspond to the direction of the movement of the helm ordered. The device to be operated by either the dynamo or transformer current, tapped from resistance plates.

162. All helm-order telegraphs, connections and instruments to be of approved design, construction and operation.

ENGINE-REVOLUTION AND DIRECTION INDICATOR.

163. The transmitter to comprise in its design, construction and operation the following features: (a) To be of the simplest possible construction; (b) to be capable of operating for extended periods with minimum attention or repair; (c) to be unaffected by moisture; (d) to be adapted for mounting on a bulkhead, or pedestal, or overhead, as required; (e) to be actuated from the shaft by a simple device; (f) to be provided with ready and simple means of adjusting its power to compensate for any change in the value of that power; (g) to be able to operate so that the pointers of the indicators will give an indication corresponding to the exact value of the number of revolutions from zero to the assigned maximum, and be entirely free from oscillation; (h) the design to be such that the value of the indications shall not be appreciably changed in any one of the indicators, should any number of the remainder be cut out of circuit.

Indicators.

164. The indicators for the bridge to be adapted for mounting singly on pedestals with the dials facing each other, unless otherwise directed. For other stations they shall be adapted for mounting on bulkheads. The scale is to be uniformly graduated, over its entire length, by single revolutions. The zero and every ten points to be marked in plain figures. The maximum number of revolutions to be as directed. The scales to be illuminated for night service by the standard instrument lamp in water-tight case. The pointer should move in the direction which the motion of the shaft will tend to move the ship. The direction of revolution, whether ahead or backing, is to be plainly marked on the respective sides of the scale. To be of water-tight construction.

165. The actuating force to be of sufficient magnitude to prevent inaccuracy of indications from ordinary changes in contact resistances.

166. All engine-revolution and direction indicators are to be of approved design, construction and operation.

Helm-angle Indicators.

167. The design, construction and operation of helm-angle indicators must comprise the following features: (a) Simplicity; (b) certainty of contact and action; (c) freedom from injury from moisture; (d) a minimum of attention and repair; (e) constancy of adjustment.

168. The actuating force is to be of sufficient magnitude to prevent inaccuracy of indications from ordinary variation of contact resistance or circuit potential.

169. The operation will include the indication in the same dial of the

angle of the tiller with the keel, and its direction, starboard or port, and be capable of operating a number of dials on the circuit. The dials to be direct reading to the extent of showing all convenient and necessary angles of helm for tactical use. The dials to be water-tight; the mechanism to be so constructed that the indications will not be materially affected by ordinary fluctuations of circuit potential; the dials to be illuminated by standard instrument lamps.

170. The transmitter is to be operated as directly from the rudderhead as practicable.

171. Helm indicators to be operated by dynamo or transformer current. When rheostats are used the connections will not be made to the end binding posts, but through a resistance, to protect the circuit from the full-dynamo potential.

172. All helm-angle indicators, connections and instruments to be of approved design, construction and operation.

TELEPHONES.

Telephones for Conning Towers.

173. Unless otherwise directed, the construction will be as follows:

174. All parts excepting the receiver to be enclosed in a water-tight bronze case. The case to be in two parts; one part to be swung on vertical hinges. The weight to be taken normally by ledges on the bottom. The joint between the parts to be made water-tight by a flat gasket. The working mechanism to be attached to the swinging part of the case, and disposed as follows:

175. The annunciator drop mechanism is to be placed at the top, and to be made in accordance with the specifications for water-tight annunciators, which will be marked as directed. The front of the case, over the bell, to be covered with gauze or perforated sheet brass to effectively transmit the sound. The base part to be surrounded by a flange flush with the back; the edge to be raised to a height sufficient to take the size of tube required for the conductors.

176. The bell to be 3 inches in diameter, of water-tight construction, and surrounded by a water-tight covering on the side, inside the case. The push button is to be of standard water-tight construction. The contacts of both bell and push-button to be of platinum.

177. The transmitter is to be of the solid-black type, operated with battery current, and without the use of an induction coil.

178. The switches are to be so connected that only the station to be communicated with is in circuit at the time, in order to avoid interference.

179. The switches are to be marked as directed, and in the same order as the drops of the annunciator. The openings for the plungers of the switches are to be practically water-tight.

180. The receiver is to be of the watch-case type; the case to be of bronze and hard, black rubber.

181. The cords for the receiver and the plunger of the automatic switch are to be led through the bottom of the case in standard stuffing tubes.

182. All terminals are to be marked with a designing letter or number.

Water-tight Telephones.

183. The water-tight telephones, for use in stations connected with the conning tower, are to be constructed as follows:

184. The transmitter is to be of the solid-black type, operated with battery current, and without the use of an induction coil. To be contained in a bronze case, pivoted back of the center of gravity, so that when the receiver is pushed into the spring clips, which are spaced around the mouthpiece, the added weight will cause them to drop and permit the mouth of the receiver to hang down. The cutting out of the transmitter to be accomplished automatically by this movement.

185. The spring clips are to be of ample strength for securing the receiver when the apparatus is subjected to severe shock or jar. The trunnions of the transmitter are to be supported by bronze arms, extending from the part of the case containing the bell, push-button and terminals.

186. The cover of the case is to be of metal, packed water-tight by a flat rubber gasket, and secured by machine screws. The terminals are to be on the inside of the case, and are to be machine screws tapped into the metal with washers, or of the binding-post type.

187. Lugs are to be run out from the sides of the case for attaching the instrument to bulkheads with three-eighths inch standard bolts.

188. The terminals to be stamped with a designating number or letter.

189. The receiver is to be of the watch-case type; the case to be of bronze and hard black rubber. The receiver cord to be run out of the interior of the case through a navy-standard box tube. Facility is to be provided in the disposition of the interior parts for running into the case at either the sides or the bottom, with the conduit, or stuffing tubes used with molding, as may be required for the location in which the instrument is installed. The covering of the cord is to be treated with an insulating varnish, to prevent the absorption of moisture. To be provided with a name-plate, marked for the name of the station with which it is connected.

Nonwater-tight Telephones.

190. Nonwater-tight telephones are for use in the captain's stateroom and the chart-house. The transmitters are to be of the solid-back type, operated by a battery, without induction coil. The receivers are to be of the watch-case magneto type, the containing case to be of bronze and hard, black rubber. The receiver cords are to be provided with a means of relieving the strains from the ends attached to the case, in order to prevent breakage of the conductors. The braids are to be treated with a non-absorbent compound.

191. The bells are to be of the vibrating type, with 3-inch gongs, to be operated by battery current. The push-button to be of standard water-tight construction. The contacts of the bell and push-button to be of platinum. The terminals are to be inside of the case; to be of the binding-post type, or machine screws with washers tapped into the metal; to be marked with a designating number. To be provided with a name-plate, marked for the name of the station with which it is connected.

TRANSFORMERS.

192. To be of the rotary direct-current type, transforming from 80 volts to 20, 13.3, and 6.6 volts. The secondary ampere capacity to be not less than 4.

193. The insulation of commutators to be mica throughout.

194. The brush-holders to be provided with stops so that the position of the brushes cannot be misplaced more than the arc corresponding to one commutator bar.

195. The wire of all windings to be run through an approved insulating varnish as it is wound on. The exterior of the coils to be well coated with varnish.

196. The spool windings to be protected from chafe or mechanical injury.

197. The insulation resistances to be not less than 1 megohm, measured hot, with 500 volts.

198. The maximum heating of the windings over the surrounding air to be not over 80° F. in the armature and 60° F. in the shunt, with full-rated load. All insulating material of absorbent nature, used in the construction, shall be so treated as to effectually prevent injury from the effects of moisture or air.

199. The journals to be provided with ring oilers.

200. The balance of rotating parts to be such that there will be no perceptible vibration.

201. Each machine to be provided with one fire-proof starting rheostat of not less than 30 or more than 50 ohms cold resistance.

202. All parts made of slate to be black enameled on all surfaces.

203. The following strictly interchangeable spare parts are to be provided with each transformer: One armature; one set of brushes, 6 total, 3 by $\frac{7}{8}$ by $\frac{1}{4}$ inch; one set of brush-holder springs, 6 total.

204. The external dimensions of transformers shall approximate the following: Height over poles, 11 inches; width over terminals, 10 inches; length with shaft, 16 inches. The weight, not including spare parts, not to exceed 80 pounds.

205. The data as to gauge, character and thickness of insulation, and total weights of each size of wire used in the windings is to be furnished with each transformer.

GENERAL ALARM GONGS.

206. To be single stroke, 12 inches in diameter.

207. To operate efficiently with from 20 to 15 volts at terminals.

208. Resistance to be not over $52\frac{1}{2}$ or under $47\frac{1}{2}$ ohms, and to take not over one-half ampere at 20 volts.

209. The adjusting spring to be of phosphor-bronze and operated from the outside of the base.

210. The base to be of the best mahogany, in two parts; one for attachment to the bulkhead, to be not less than three-fourths of an inch thick; the other to be not less than one-half of an inch thick at back.

211. The side of the base opposite the striker to be stamped "Top," and both parts marked with a serial number on each side of the joint.

212. Brass screws only to be used for holding together.

213. The two coils of the magnet to be thoroughly insulated from the cores. The insulation resistance to be not less than 1 megohm, measured with not less than 100 volts. The magnet heads to be hard rubber. The winding to be of single cotton-covered copper wire, to be run through an approved insulating varnish as it is wound on. The exterior of the coils to be wrapped with insulating tape laid closely, varnished and secured to effectually prevent access of moisture.

214. The connections between coils to be rosin soldered, taped, and varnished. The leads from magnets to binding posts to be made with standard No. 14 B. & S. G. conductor.

215. The binding posts to be inside of outer base part, one on each side, and to make the connections between magnet and circuit under washers by screw nut.

RHEOSTATS FOR TAPPING LIGHTING CURRENT AT REDUCED VOLTAGE FOR INTERIOR-COMMUNICATION CIRCUITS.

216. Shall be of the enamel type. The capacity to be such that the maximum heating of the surface shall not be over 70° F. in excess of that of the surrounding air. The taps shall be taken from between two equal portions of the resistance, the value of each being not less than one-fourth of the total, so that the circuit may not be exposed to the full-line voltage in the case of grounds. The terminals to be marked with a designating number or letter. The rheostat to be marked on a name plate with the title of the circuit which it supplies. The factory number is to be also plainly marked. The resistances, size and number of the plates to be as directed.

SEARCH-LIGHT PROJECTORS.

217. They will be designated as follows: First, by the type, as hand controlled, electric controlled. Second, by the diameter of the mirror, as 18-inch, 24-inch, 30-inch.

Hand-control Projector.

218. It shall, in general, consist of a fixed pedestal or base, surmounted by a turntable carrying a drum. The base shall contain the turning mechanism and the electric connections, and be so arranged that it can be bolted securely to a deck or platform.

219. The turntable to be so designed that it can be revolved in a horizontal plane freely and indefinitely in either direction, both regularly and gradually by means of suitable gearing, and rapidly by hand; the gearing being thrown out of action.

220. The drum to be trunnioned on two arms bolted to the turntable, so as to have a free movement in a vertical plane, and to contain the lamp and reflecting mirror. The drum to be rotated on its trunnions, both regularly and gradually by means of suitable gearing, and rapidly by hand; the gearing being thrown out of action. The axis of the drum to

be capable of a movement of not less than 70° above and 30° below the horizontal.

221. The drum to be thoroughly ventilated and well-balanced; to be fitted with peep sights for observing the arc in two planes, and with hand-holes to give access to the lamp. It must be so designed that either a Mangin or a parabolic mirror can be used, and a means for balancing it with either mirror must be provided.

222. The mirror to be made of glass of the best quality, free from flaws and holes, and having its surfaces ground to exact dimensions, perfectly smooth and highly polished. Its back to be silvered in the most durable manner; the silvering to be unaffected by heat. To be mounted in a separate metal frame lined with a non-conducting material, in such a manner as to allow for expansion due to heat and to prevent injury to it from concussion.

223. The lamp to be of the horizontal carbon type, and designed for both hand and automatic feed. The feeding of the carbons must be effected by a positive mechanical action, and not by springs or gravitation. It must burn quietly and steadily on an 80-volt circuit in series with a regulating rheostat, and shall be capable of burning for about six hours without removing the carbons.

224. The front of the drum to be provided with two glass doors, one composed of strips of clear plate glass, and the other of strips of plano-concave glass lenses, so designed as to give the beam of light projected from the mirror a horizontal divergence of at least 20° . The doors to be interchangeable, and to be so arranged that either can be put in place on the drum easily and quickly.

Electrically-controlled Projector.

225. To be in all respects similar to the hand controlled, with the addition of two shunt motors, each with a train of gears; one motor for giving the vertical and the other the horizontal movement of the projector. The motors and gears to be contained in the fixed base, and to be well protected from moisture and mechanical injury. A means to be provided for quickly throwing out or in the motor gears, so that the projector can be operated either by hand or by motor, as desired.

226. The motors to be operated by means of a compact, light and water-tight controller, which can be located in any desired position away from the projector. The design of the controller to be such that the movement of a single handle or lever, in the direction it is wished to cause the beam of light to move, will cause the current to flow through the proper motor in the proper direction to produce such movement. The rapidity of the movement of the projector to be governed by the extent of the throw of the handle or lever. A suitable device to be included whereby the movement of the projector can be instantly arrested when so desired.

227. All projectors to be finished in a dead-black color throughout, excepting the working parts, which shall be bright.

228. The general dimensions of projectors to be within the following limits:

Dimensions.	Diameter of base.	Height of centre of mirror.	Weight complete.
	Inches.	Inches.	Pounds.
18-inch hand controlled	22	46	425
18-inch electrically controlled	22	46	600
24-inch hand controlled	24	56	725
24-inch electrically controlled	24	56	875
30-inch hand controlled	26	58	925
30-inch electrically controlled	26	58	1,075

229. The lamps to be designed to produce the best results when taking current as follows: 18-inch, 30 to 35 amperes; 24-inch, 50 to 60 amperes; 30-inch, 75 to 90 amperes.

230. The 18-inch projector shall project a beam of light of sufficient intensity to render plainly discernible, on a clear, dark night, a light-colored object 10 by 20 feet in size, at a distance of not less than 4,000 yards; the 24-inch projector, at a distance of not less than 5,000 yards; and the 30-inch projector at a distance of not less than 6,000 yards.

INSTALLING ELECTRIC PLANTS AND ELECTRICAL MEANS OF INTERIOR COMMUNICATION ON BOARD SHIPS OF THE UNITED STATES NAVY.

ELECTRIC PLANTS.

CONDUIT AND MOLDING.

1. *Conduit* will be used for all spaces in the water-tight system. It is to be preferred for use in all other locations; but in spaces where it may not be desirable to run it over woodwork, as in chart-house, emergency cabins and officers' quarters, standard wooden molding may be used.

2. It will be fastened to the metal of the ship by stout metal straps at such intervals as will firmly secure it in place, prevent undue vibration, and withstand any unusual strain to which it may be subject.

3. It shall be continuous and to be made water-tight at bulkheads by approved flanges and stuffing boxes.

4. Leads through armor will be made by tapping in on both sides; continuity to be secured by smooth turning the end of one of the conduits, to a depth of the thread, for a length equal to the untapped thickness of the armor; the ends to butt together.

5. Connections to standard junction boxes, switches and receptacles to be made by tapping into a boss on a plate to be screwed to the box. A

box of cast metal with bosses for tapping in, and fitted with standard interior fittings and covers, may be used instead of standard boxes. Flanged feet to be provided in each case for screwing the appliance in place, the flange to set the box clear of the metal of the ship.

6. Both positive and negative legs of the same circuit will be led in the same conduit for all conductors of and below 30,856 cm.; all conductors above 30,856 cm. to have a conduit for each leg. A clearance of not less than three-sixteenths of an inch to be allowed for drawing in and out. When double conductor plain is to be used, a clearance of not less than one-eighth of an inch is to be allowed.

MOLDING.

7. The backing strip, laid in advance, will be secured by brass machine screws (No. 14-20) placed alternately on the sides, and so spaced (about 12 inches apart) that no screws will come under junction boxes, switches or receptacles; the screw heads being countersunk.

8. *Molding* to be secured in place through center wall with brass wood screws (No. 8-1½ inches). Screws to be placed, as directed, at intervals not greater than 12 inches; the screw-heads being countersunk.

9. *Molding* to be finished in the same manner as the surrounding wood-work, and all molding and backing except hard wood shall be thoroughly coated with white-lead paint after being fitted and before being secured in place. All molding to be capped, the capping being secured to the side walls by round-head brass screws placed not more than 12 inches apart.

10. In running the *backing strip*, a path that will clear usual sized bolt heads and other projections will be chosen. To avoid such obstacles, small detours from a direct lead will be allowed.

11. The part of the *molding* under the wire gutters is never to be reduced in thickness below three-eighths of an inch.

12. Junction boxes, switches and receptacles (combined or separate) will be separated from metal surfaces by at least three-quarters of an inch of wood, and secured with brass wood screws entering the wood for one-half of an inch. *It is required that at least one-quarter of an inch of clear solid wood shall separate all wiring accessories from the metal of the vessel.*

13. The junction boxes, switches and receptacles being wider than the backing strip, the latter will always be built out to bring it flush with their sides, except where a number of moldings are grouped together, as in passageways where feeders are run; then these boxes can be let into adjacent moldings (never more than three-sixteenths of an inch), and so disposed that no two in adjacent moldings will be abreast. *They are never to be located over screws securing the backing in place.*

14. Controlling switches, feeder junction boxes and distribution boxes are to be placed with especial reference to convenience of access.

15. Where several leads of molding run side by side, a backing strip of the required thickness in one width may be used under all.

WIRING.

16. The two-wire system to be used.

17. All wire to be that prescribed by the specifications for standard insulated wire supplies.

18. All wires to be run where directed and where accessible; those for circuits used in action to be kept below the water-line as much as possible.

19. Thorough water-tightness is to be observed for all leads into wiring appliances and fixtures, and through all bulkheads and decks.

20. The outer tape and braid on the ends of all conductors on lighting circuits, where such conductors are connected in fixtures and wiring appliances, is to be removed, exposing the vulcanized rubber underneath to within one-eighth of an inch of the outside of the gland.

21. Special care must be observed in every instance not to cut into or otherwise injure the vulcanized rubber.

22. When the tape and braid is removed for connecting up movable fixtures, the braid ends shall be protected from fraying by whipping the end of the braid and varnishing.

23. All wire run through decks or bulkheads, where molding is used, must be led through standard stuffing tubes; when running through beams or bulkheads, and water-tightness is not required, the hole for the lead must be bushed with hard rubber, the hard rubber extending into the molding on each side.

24. No feeders or mains to be led overhead in locations subject to heat, or through or into coal bunkers, unless specially authorized.

CIRCUITS.

25. The circuits will be divided into two classes:

1. Lighting circuits.
2. Motor circuits.

LIGHTING CIRCUITS.

26. Lighting circuits will comprise the following divisions, according to the service required:

First. *Continual service*, to include lights at or in (and to supply energy for operating portable ventilating sets)—

Passages.	Ventilating fans.
Fire pumps.	Motors.
Bilge pumps.	Inner-bottom manholes.
Hand pumps.	Auxiliary condensers.
Ash hoists (lower).	Auxiliary boilers.
Bunkers.	Dynamo-room.
Workshops (lower).	

Second. *Battle service*, to include lights at or in (and to supply energy for operating smoke fans, instruments, and firing apparatus on dynamo circuit)—

All guns.	Conning tower.
Ammunition-handling rooms.	Central station.
Magazine light boxes.	Armory.
Shell-room light boxes.	Range-finder.
Ammunition-room light boxes.	Military tops.
Ammunition hoists.	Hydraulic rooms.
Turret turning gear.	Instruments.
Torpedo compressors, racks and tubes.	Signal tower.

Third. *General service*, but not in action (and to supply energy for operating bracket and desk fans)—

Chart-house.	Distiller.
Officers' quarters.	Workshops (upper).
Petty officers' quarters.	Diving lamps.
Offices.	Closets.
Galleys.	Washrooms.
Dispensary.	Lavatories.
Sick bay.	Heaters.
Standing lights.	Side ladders.
Drying-rooms.	Propeller booms.
Winches and cranes.	Military masts (inside).
Issuing-rooms.	Ground tackle.

Fourth. *Sea service*, to include lights at or in (and to supply energy for operating instruments)—

Engine-rooms.	Forced draught.
Fire-rooms.	Chart table.
Steering-rooms.	Shaft passages.
Steering wheels.	Instruments.

Fifth. *Day service*, extinguished at 9 P. M., to include lights in (and those on the top or sides of superstructure and deck houses)—

Hammock spaces.	Storerooms.
Holds.	Mess-rooms.
Steerage country.	

Sixth. *Special service*, to include—

Signal lights.	Projectors.
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27. Lights in compartments and their adjoining compartments which have the same kind of service (as outlined under the separate divisions of *general*, *sea* and *day service*) to be grouped on the same mains and controlled by a switch in a convenient location.

28. The maximum load for all lighting feeders, excepting those for search-lights, shall not exceed 75 amperes.

29. In case the current required for any service exceeds 75 amperes, a sufficient number of separate feeders shall be provided. Feeders will be numbered and designated by the terms *forward* and *aft*, by decks or specific compartments, and further divided into *starboard* and *port*, as may be required.

30. Lights under the division *sea service* will be on the mains fed by the feeders for *continual service*; those for *day service* will be on the mains fed by the feeders for *general service*.

31. Lights on mains fed by feeders for *battle service* to supplement those on feeders for *continual service*.

32. A *signal circuit* shall be provided to include and feed the double truck lights, night signalling sets, binnacle lights; and outlets for running lights, top-lights, stay and stern lights, and for signal use.

33. The signal circuit shall be fed by separate feeders leading directly from the dynamo-room switchboard, to connect by transfer switches to

adjacent feeders of the battle service; the transfer switches to be located in the chart-house.

34. The *search-lights* shall be fed by separate circuits, each leading from the dynamo-room switchboard through a rheostat, ammeter, and D. P. automatic circuit-breaking device; to be placed in vertical lines on separate instrument boards.

35. The circuit-breaking device to be of approved design, construction and operation; and to have a capacity of and be capable of being adjusted to a current of 50 per cent. in excess of the normal working current of the lamp in circuit. Each circuit shall have its own voltmeter.

36. A rheostat in a non-combustible frame shall be supplied and fitted in the dynamo-room for each search-light. The rheostat to have a dead resistance equivalent to a drop of 20 volts for the normal current at which the lamp operates, and also an adjustable portion, in not less than ten divisions, to give a drop of 10 volts for the normal current of the lamp; the resistance to be measured hot. The rheostat to be of approved design, construction and operation. The rheostats will be marked "high" and "low" to indicate the movement of the handle for increased or decreased current.

37. Search-light circuits shall have no connection with the circuits for incandescent lights, except as provided for on the switchboard.

38. Each search-light circuit shall lead to its own pedestal, where it will terminate in an approved water-tight receptacle, the pedestal to be located as directed.

39. The area of cross section of search-light feeders shall be on the basis of at least 500 circular mils per ampere at full load.

40. Controller receptacles for each electrically controlled search-light will be installed at locations convenient for the operation of the controller; the pressure wire for the motors to be connected to the adjacent transfer circuit.

MOTOR CIRCUITS.

41. Each motor circuit shall be connected to the dynamo-room switchboard by a D. P. automatic circuit-breaking device of approved design, construction and operation; to have a capacity of, and be capable of being adjusted to, a current 50 per cent. in excess of the normal rated load of the circuit.

42. Each motor of and above 4 K. W. will have a separate feeder leading from the dynamo-room switchboard.

43. Motors below 4 K. W. will be supplied by the same feeders, the maximum load on any one feeder not to exceed 75 amperes; in case the current required exceeds 75 amperes, a sufficient number of feeders shall be provided. Motors which are located in spaces above the protective deck and not protected by armor, and which are on the same circuit with protected motors, will have a cut-out switch in their mains, so that any damage to the unprotected portion of the circuit will not affect the remainder.

44. When more than one motor is fed by the same feeder the main leading to each motor shall have in circuit an automatic circuit-breaking

device, either included in or separated from the controller, which shall open the circuit both in case of failure of the line voltage and 50 per cent. overload.

45. If not included in the controller the automatic device will be located conveniently near it.

46. The controller and automatic circuit-breaking device to be of approved design, construction and operation.

FEEDERS AND MAINS ON LIGHTING CIRCUITS.

47. The area of cross section of the feeders and mains on the lighting circuit shall be such that the fall in potential from the dynamo terminals to the most distant outlet shall not be more than 3 per cent. at the normal load of the feeder. The size of feeders or mains to be the same throughout their entire length; no "tapering" to be permitted.

48. There shall be no soldered or other joints in feeders or mains except those made in the standard appliances.

49. No feeder or main will have a less area of cross section than 1,000 circular mils per ampere at the normal load, to be reckoned at the rate of nine-tenths ampere per lamp of 16-candle power.

50. The feeders shall be controlled by switches and fuses on the switch-board.

51. Mains which tap into feeders may be arranged in loops for the purpose of equalizing drops; submains shall tap into mains only, with branches leading to the outlets.

52. No wiring appliance other than switches and feeder junction boxes are to be placed on feeders.

53. Wherever mains are led off from feeders it shall be done through standard feeder junction boxes, having double pole fuses of standard pattern, which shall blow on the basis of 1 ampere per 500 circular mils of the main.

54. Not more than two feeders shall ever be interconnected, and no feeders shall be interconnected through their mains.

55. Feeders which interconnect shall have an area of cross section of not less than 1,500 circular mils per ampere at the normal load.

56. Feeders for *continual service* and *battle service* are to be interconnected for their own division of service. Mains for any division of service are to be interconnected either to their adjacent mains or to those of the deck next above, but not more than two mains shall be so interconnected. Interconnected mains shall have an area of cross section of 1,500 circular mils per ampere at normal load.

57. All mains and submains are to be made controllable by switches, placed near the junction boxes.

58. All outlets shall be fed from the mains by branch wires, which shall be an unbroken continuation from junction box to outlet, except when specially authorized.

59. The wire used for branch circuits shall be the standard No. 14 B. & S. G. Leads from distribution boxes to single outlets may be run with double conductor plain.

60. When molding is used, each outlet on *continual*, *battle* and *sea* service shall have a separate three-way branch junction box; four-way branch junction boxes may be used in this case for outlets on general or *day* service.

61. In offices and staterooms, two outlets, one for desk light, the other for desk fan, may be installed on the same branch circuit.

62. Fuses for branch junction boxes to be for the normal rated load of 4 amperes, and to blow at 8 amperes. Fuses for feeders and mains to be at the rate of 1 ampere per 1,000 circular mils, and to blow on the basis of 1 ampere per 500 circular mils.

63. No individual switches shall be placed on branches of *continual service* or *battle service*. The lights on the branch circuits for these services shall be controlled by a group switch, except for those to be used as standing lights.

FEEDERS AND MAINS ON MOTOR CIRCUITS.

64. The area of cross section of the feeders, on circuits for motors of and above 4 K. W. shall be such that the fall in potential from the dynamo terminals to the motor terminals shall not be more than 5 per cent. at the normal load of the feeder; for other motor feeders to be as prescribed for lighting feeders. Whenever possible, the feeders for motors of and above 4 K. W. shall be an unbroken continuation from the switchboard to the controller contacts.

65. Wherever mains are led off from feeders it shall be done through standard feeder junction boxes, having double pole fuses of standard pattern, which shall blow on the basis of double the normal load of the motor.

PERMANENT AND MOVABLE FIXTURES.

66. Silver-plated fixtures to be used in cabins, wardroom and junior officers' quarters only. Bronze fixtures to be used in offices, and quarters assigned to warrant officers and chief petty officers.

PERMANENT FIXTURES.

67. *C. F. No. 1*, *C. F. No. 3* and *Commercial C. F.* to be used in cabins and wardroom only.

68. *C. F. No. 2* to be used for general overhead lighting in passages, crew spaces and chart-houses on *day service*, and quarters for warrant and chief petty officers. For other spaces the *steam-tight* fixture is to be preferred for overhead lighting, and to be fitted with guard wherever the globe is liable to breakage.

69. If lighting is desirable on both sides of a bulkhead, it will be provided by separate lights.

70. *Bunker* lights are to be installed overhead between the frames in which each of the coal chutes are placed; a light to be installed on the bunker bulkhead conveniently near the doors leading to the fireroom, that the part of the bunker in the vicinity of the door may be lighted.

71. *Bulkhead* fixture to be used for standing lights for all locations except quarters and offices. It is not to be used for overhead lighting

except in those locations where the *steam-tight fixture* would allow insufficient head room, and where a guarded fixture is required.

72. *Brackets* are the standard fixtures for side lighting for quarters and offices.

73. *Steam-tight* fixtures, in addition to the use prescribed under C. F. No. 2, shall be fitted as required to thoroughly light the lubricators under engine cylinders and steam chests.

74. Whenever possible, the conduit leads to the cylinder and steam-chest lights shall be from overhead to avoid the effect of vibration.

75. *Double truck* lights are to be installed on the fore and main masts of vessels having two or more masts.

76. Single-masted vessels to have a double truck light on the mast. Torpedo-boats and vessels of special design will not be fitted with double truck lights unless specially authorized. Double truck lights are to be furnished with, and connected to, two lengths of double conductor plain and two receptacle plugs; the length of conductor to be that best adapted for connection to the receptacles; the receptacles to be without switches and located, in case of use with topmasts, on the bibbs or athwartship brackets of the military top; in the case of pole masts the receptacles will be located under the upper deck in which the mast partners.

77. Leads from the controller to the receptacles will be the standard No. 14 B. & S. G. conductor, and will be run as best adapted for the particular vessel.

78. The controller shall be in strict conformity with the Bureau's designs.

79. *Binnacle light* to be connected to a branch junction box on the signal circuit by a suitable length of double conductor plain, led through the pedestal to the plunger contacts.

MOVABLE FIXTURES.

80. Desk lights will be furnished with, and connected to, a length of double conductor, silk, and an attachment plug; the length of conductor will be that best adapted to the location, but in no case to be less than 15 feet.

81. Not less than two hooks for suspending the shade holder of the desk light will be installed; to be conveniently located for use.

82. Four cup hooks, two on the ceiling and two on the bulkhead, will be placed in locations convenient for suspension of the bight of the conductor.

83. All the foregoing hooks to be of the same finish as the fixture.

84. *Running lights, towing and top-lights* will be furnished with, and connected to, two lengths of double conductor plain and two receptacle plugs; the lengths of conductor to be that best adapted for connection with the receptacles.

85. Receptacles for the foregoing lights are to be placed conveniently near the lights and to be without switches. The junction boxes to be easily accessible for replacing and inspecting fuses.

86. *Magazine lanterns* will be furnished with, and connected to, two

lengths of double conductor plain of conductor to be that best adapted for the receptacles.

87. The two switch-and-receptacle in a wooden block fitted in the recess to, and tap into the sides of, the zinc or light box must be of brass.

88. Signal lanterns to be furnished with rails for each dynamo; to be that which is required for double conductor plain and a

89. Unless otherwise directed will be provided for each vessel.

90. Deck lanterns and portable a length of double conductor number allowed shall have a length of 50 feet, and the remainder

91. Special care must be portable, to prevent grounding.

92. Outlets for portables inner bottoms, and where repair of machinery. They are as the use of the fixture lighting for repair work on

FOUNDATIONS.

93. Battle lanterns to be double conductor plain and be that best adapted for

94. Switch and receptacle battle-service circuit in mill and at upper end of annular

95. A standard battle these stations, so that the for immediate service.

96. Portable hooks, for lanterns, to be provided the fixtures in turrets or

97. Cargo reflector, for will be furnished with conductor plain and a re

98. Navigator's lanterns of double conductor plain

99. Diving lanterns double-conductor diving connected to a 25-ampere

100. A 25-ampere and quarter, for use of the vessel, extra gutters

101. Stay lights double conductor; the hoist of at least an

102. *Telegraph lights* to be furnished with, and connected to, a length of double conductor plain and a receptacle plug; the length of conductor to be that adapted for connection with the switch and receptacle.

103. The switch and receptacle to be located on the column of the mechanical engine-room telegraph.

104. The lamps of the *night-signalling sets* to be connected to the standard cable.

105. The lamp ladder will be suspended to an outrigger, to be fixed or pivoted as required, and fitted as best adapted for the use of the particular vessel. The lower end of the lamp ladder to be steadied by a galvanized-wire cable setting up with a turn buckle and plate inboard.

106. The keyboard to be secured on a bracket fastened to the bridge rail or on a suitable pedestal. A metal cover to be fitted to protect the keyboard from the weather.

107. The outriggers, keyboard, bracket and cover to be in conformity with the Bureau's designs.

108. The signalling set to be connected with a 25-ampere switch and receptacle, installed on the signal circuit.

STEAM PIPES AND FITTINGS.

109. Steam-pipe connections are to be so made that steam can be available from either the main or auxiliary boilers. All piping to be led with especial reference to head room and facility for removal and repair of pistons and valves. No joints to be placed over or in line with the dynamos or switchboard.

110. The main steam pipe is to be fitted with a stop valve, reducing valve and separator, to be located in the dynamo-room unless otherwise directed.

111. A trap is to be provided and connected to take the condensation of the separator, drip pipes of the engines, and drains from lower bends of piping.

112. A branch steam pipe, fitted with a stop valve near the main steam pipe, will be led for supply to each generating set.

113. All piping for steam and exhaust to be of copper.

114. The main exhaust pipe is to be fitted with a valve, placed where it will be accessible and in best position to ensure minimum condensation in the branch exhausts; and also with an oil eliminator, to collect the oil from the exhaust steam on its passage to the condenser, in all cases where cylinder lubricators are fitted on the steam pipes.

115. A sight feed cylinder lubricator is to be fitted in a suitable position on each branch steam pipe, if so directed.

116. The main steam pipe is to be tapped for the connection to the steam gauge; the main exhaust pipe to be tapped for connection to the combined vacuum and back-pressure gauge.

117. The steam gauge, clock and vacuum gauge are to be mounted together on a suitable backboard.

118. All piping is to be covered with an approved non-conducting material.

DYNAMO-ROOM ACCESSORIES.

119. The following are to be provided in the dynamo-room: An oil filter well secured and of large capacity, that it may also serve the purpose as an oil receiver. If the construction of the filter includes heating coils, it will be connected with the steam and drip mains.

120. A *save-all*, for catching the waste oil from the drainpipe of the engine base.

121. An overhead *hoist* and *traveller*, with rails for each dynamo for handling the armatures.

122. *Lockers*, for stowage of instruments of frequent use, and a few pockets for cotton waste, etc.

123. A *wrench* and *tool board*, conveniently placed and arranged to secure the tools in place.

124. The following will be placed in the dynamo-room, if space permits; if not, in the electrical storeroom:

125. *Oil tanks*, for cylinder and lubricating oil, to be supplied with covers, trays and facilities for filling and cleaning; the capacity to be as large as the available space will permit.

126. A *work-bench* and *vice*.

127. All accessories and appliances for dynamo-rooms and steam connections to be of approved design, operation and construction.

FOUNDATIONS.

128. The deck under all generating sets is to be so supported and strengthened that it will easily sustain the weight and insure that the framing of the vessel will assist in securing rigidity and preventing vibration.

129. The bed plates should preferably rest in a metal pan, with edges turned up about two inches to catch waste oil and water; the pan to rest on and be secured to a wooden base, not less than two inches in thickness to deaden vibration.

130. Cutting waterways in the wooden base and lining with lead is to be avoided, as the lead is readily injured and cut.

131. The wooden base should be protected from access of water in order to secure durability. All foundations to be leveled.

SWITCHBOARD AND CONNECTIONS.

132. Switchboards are to be installed with an especial reference to accessibility, and freedom from access of oil thrown by the moving parts of dynamos and engines.

133. It is desirable that sufficient room be allowed between the bulkheads and back of the switchboard to facilitate connections.

134. The slate panels constituting the switchboard shall be separated from the metal framework (or bulkhead) by a wooden framing; the wooden framing to embrace and lap over the edge of each panel, to hold it together in case of breakage. The panels to be secured to the framing by bolts, with countersunk heads, which will be in addition to the securing the framing to the metal framework; the holes for the bolts

have ample clearance, so that the panels will be held by the pressure of the nuts only; the weight to be supported by a ledge on the wooden framing.

135. Dynamo and shunt rheostat leads will be installed in the standard molding prescribed for that use.

136. Dynamo and equalizer leads will have a cross section on the basis of 1,500 circular mils per ampere of the rated capacity of the dynamo.

137. When three or more dynamos are to be connected to the same switchboard, especial precaution is to be taken to insure a practical equality in resistance of the equalizer leads.

138. A double pole automatic circuit-breaking switch, of approved design, construction and operation will be connected in the positive and equalizer dynamo leads on the switchboard.

139. All rheostats are to be installed with reference to freedom from access of oil thrown by the moving parts of the engine.

140. Search-light rheostats to be located as conveniently near to the instrument board as space will admit, and to be marked with the names corresponding to their respective lights.

141. Switchboards and rheostats are to be raised as high above the deck as convenience of access to the appliances and available space will permit, and to be placed clear of the dripping from dead lights in the deck overhead.

ELECTRICAL INTERIOR COMMUNICATIONS.

CONDUIT AND MOLDING.

142. *Conduit* will be used for all spaces in the water-tight system. It is to be preferred for use in all other locations; but in spaces where it may not be desirable to run it over woodwork, as in chart-house, emergency cabins and officers' quarters, standard wooden molding may be used.

143. It will be fastened to the metal of the ship by stout metal straps, at such intervals as will firmly secure it in place, prevent undue vibration and withstand any unusual strain to which it may be subject.

144. It shall be continuous and to be made water-tight at bulkheads by approved flanges and stuffing boxes.

145. Leads through armor will be made by tapping in on both sides, continuity to be secured by smooth-turning the end of one of the conduits, to a depth of the thread, for a length equal to the untapped thickness of the armor; the ends to butt together.

146. Connections to standard connection boxes to be made by tapping a short nipple, with right and left coupling, directly into the box. Standard bell-wire molding to be installed, as prescribed for that for lighting and motor circuits.

WIRING.

147. All wire, whether for use on dynamo current, battery or transformer, to be that prescribed by the specifications for bell wire and interior-communication cable; the specified bell wire and interior-communication cable to be used on all circuits, whether for call bells, telephones,

telegraphs or indicators, excepting where a standard special cable has been specified for a particular use.

148. Interior-communication cable to be used for all leads below the main deck, excepting for quarters and office calls in the nonwater-tight system; the governing principle to be to secure thorough water-tightness between the water-tight and nonwater-tight sections of the vessel, which will necessitate in some cases the extension of the cable into the nonwater-tight sections through the water-tight bulkhead. Interior-communication cable is also to be used for circuits to the conning tower, chart house, military top, signal towers, emergency cabins and bridge.

149. Not more than 20 wires will be used in any one lead.

150. Type A 20 or Type 40 connection boxes will be used, as may be most suitable for the particular case, special reference being had to reducing the number of boxes to a convenient minimum.

151. All wire or cable to be run where directed and where accessible that for circuits used in action to be kept below the water-line as much as possible.

152. Circuits used in action which are protected, and which are connected to exposed circuits, to be provided with action cut-out switch for cutting out the exposed portions of the circuits. Thorough water-tightness is to be observed for all leads into wiring appliances, through the bulkheads below the main deck, and through all decks.

153. The outer braid and tape on the ends of all bell wire and cable where they are connected through gaskets in boxes, cut-outs or instruments, is to be removed, exposing the vulcanized rubber underneath within one-eighth inch of the outside of the gland; special care to be observed not to cut into or injure the vulcanized rubber.

154. All wire and cable run through decks or bulkheads, when molding is used, must be led through standard stuffing tubes; when running through beams or bulkheads, and water-tightness is not required, the hole for the lead must be bushed with hard rubber, the hard rubber extending into the molding on each side.

155. No circuits to be led overhead in locations subject to heat, through or into coal bunkers, unless specially authorized.

156. All conductors are to be run in conduit or molding. No cleats to be permitted in any appliances unless specially authorized and approved.

157. Tag boxes are to be provided with metal name-plates marked to correspond with the numbers shown on the drawings of the circuits.

158. The number of soldered joints in single-conductor circuits will be kept at a minimum, and entirely avoided, if practicable. When solder joints are made, it is to be done by first cleaning the wires, then twisting them closely together and heating sufficiently only to cause the solder to flow freely into the joint. The heating will preferably be done with a soldering iron. If a soldering lamp is used, special precaution will be taken to prevent overheating of the rubber.

159. The solder for making joints shall be of the rosin-core type; the use of other than rosin to be used.

160. All joints shall be taped while warm with a layer of rubber tape.

and covered with an outside layer of cotton tape for protection against mechanical injury.

161. A dry location will be selected when joints are to be made in leads.

162. The interstices between wires or variation from full circle in outer surface, where large enough to admit of it, are to be filled with rubber tape. The tape for filling is to be cut to one foot in excess of the length of the tube, then soft rolled on itself, the axis of the spiral being in the direction of the length of the tape. These are to be laid in the interstices so that 6 inches will extend beyond each end of the tube when the conductors are in their normal position. The whole is then to be securely wrapped with rubber tape, lapping one-half of its width to same length as the fillers and to a sufficient thickness at the gasket to make it bind the taped conductors tightly. Where No. 16 B. & S. G. battery wires form sole components, they shall be closely grouped together. The inner interstices need not be filled, and the outer only when their number is other than seven and nineteen. The outer wrapping is to be done in every case where there is sufficient difference between diameters of the tube and laid-up conductors. The fillers should not be so made up as to increase to any degree the outer diameter of the cable.

163. It is intended that the tubes will be made practically water-tight by this method, and the work must be done to insure this result as far as possible.

164. All call bells and push-buttons to have name-plates; those for the bells to indicate the station from which the call is sent, and those for the buttons to indicate the station to which sent.

CIRCUITS.

165. The circuits will be divided into the following classes:

1. Call-bell circuits.
2. Telephone circuits.
3. Telegraph circuits.
4. Indicator circuits.
5. Fire-alarm circuits.
6. General-alarm circuits.

166. *Call-bell circuits* will comprise—

- Quarter's and office calls.
- Voice-tube calls.

Wherever necessary to prevent confusion in calls to the same location, an annunciator will be installed, with a convenient number of drops.

167. *Quarter's call* will include the following:

168. *Commander-in-chief.*—Calls from staterooms, bathroom, saloon and office, to orderly and pantry; also a call from the signal tower to the orderly. Calls in each saloon, to be located at the table, to call the orderly and pantry.

169. *Captain.*—Calls from staterooms, bathroom, saloon and office, to orderly and pantry; a return call from the cabin to the chart-house, and calls from the emergency cabin to the chart-house, orderly and cabin pantry. Calls in each saloon, to be located at the table, to call the orderly and pantry.

170. *Wardroom*.—Calls from staterooms, bathroom and table, to the pantry; one table call to call the messenger. Additional calls in staterooms to be installed as follows:

Executive officer.—Call to office, master-at-arms and yeoman.

Chief engineer.—Call to each main engine-room and to the log-room.

Paymaster.—Call to pay office.

Surgeon.—Call to the dispensary.

Navigator.—Call to office and dynamo-room.

Marine officer.—Call to first sergeant.

171. *Junior officers*.—Calls from each stateroom and table to the pantry. In ships having no stateroom the call to be from the table only.

172. *Warrant officers*.—Calls from staterooms and mess-room to pantry. A call will be installed, at some convenient place, for the officer of the deck to call the cabin orderly when stationed on a lower deck; also a call, located on each deck used for quarters, to announce the departure of boats; the latter to have 6-inch single-stroke bell.

OFFICE CALLS.

173. *Executive officer*.—Calls to master-at-arms, yeoman and wardroom pantry.

Paymaster.—A call to the wardroom pantry.

Navigator.—Call to the dynamo-room and wardroom pantry.

VOICE-TUBE CALLS.

174. A return call will be installed at each end of continuous voice tubes. When voice tubes are connected through valves or hand connections, a return call will lead to the central station.

TELEPHONE CIRCUITS.

175. Telephonic connections between different locations are to be installed where directed. They are intended to take the place of, or to supplement, voice tubes between the locations. They will include the following: A direct circuit from the captain's cabin to the chart house. A circuit connecting the conning tower to the central station, turrets, torpedo tubes, steering engine-room and that main engine-room in which the voice tubes terminate. The locations mentioned to call the conning tower through an annunciator; the connections from the conning tower to be controlled by switches; the annunciator, transmitter, push-button, switches and bell to be combined in the same case. The switches to have name-plates indicating the connection. When installing telephones, positions will be selected for the instruments where least exposed to vibration; the mouthpieces to be 5 feet above the deck. Sections of telephone circuits which are run in molding, and with separate wires, are to be tagged at convenient intervals for facilitating tracing of wires; the ends of all wires, whether separate or in cable, to have metal tags marked to distinguish the particular wire. All circuits to be on separate batteries. A blue-print diagram of leads of the circuits, the location of batteries, inlets and tag boxes, with all connections, to be furnished. The

insulation resistance between circuits, and from each circuit to ground, to be not less than 1 megohm. The circuits to the conning tower shall be run inside of the armored tube; any sections of the conning-tower circuits, which are not protected by armor, shall be connected through an action cut-off switch.

BATTERIES FOR QUARTERS' AND OFFICE CALLS.

176. The circuits will be divided into separate circuits, each to have its own battery. The batteries to be placed in battery lockers having a separate partition for each cell; the lockers to be located as near the respective annunciators as practicable; the partitions for the cells to be $4\frac{3}{4}$ by $4\frac{3}{4}$ inches inside measurement, and also to be on the front of the cells to prevent their falling out when the locker door is opened. The distance between shelves to be 9 inches. The door to be provided with a snap catch and a name-plate indicating the name of the circuit which the battery supplies.

BATTERIES FOR VOICE-TUBE CALLS, TELEPHONES, FIRE-ALARM, AND GENERAL-ALARM CIRCUITS.

177. A battery locker shall be provided in which all the batteries for voice-tube calls, telephone calls and those for operating general-alarm gongs shall be located. The cells to be grouped on trays containing not more than 12 cells each; each cell to be placed in a separate compartment $4\frac{3}{4}$ by $4\frac{3}{4}$ inches, separated by partitions 3 inches in height; each tray to be provided with handles for lifting, with push bolts for securing in place, and with a name-plate indicating the name of the circuit which the batteries of the tray supply. The voice-tube calls shall be on separate-battery circuits, and will include one of the larger annunciators with their push-buttons, and any separate bell or push-button call that perform similar service. The smaller annunciators, with their push-buttons and bells, may be collected in groups of two or three on the same battery circuit. It is intended in the foregoing arrangement of annunciators to avoid general interruption of service in case of fault in any circuit, and also to decrease the work on the batteries. The annunciators to be as near the voice tubes as practicable and in a safe and visible location. Rotary transformers, to be located in the dynamo-room, when practicable, will generally be used in lieu of the batteries on the foregoing circuits excepting for quarters, telephone and office calls; the transformers and batteries to be connected to the circuits through the standard transfer switch.

PUSH-BUTTONS.

178. Push-buttons in quarters shall be of the nonwater-tight type; and, in staterooms, shall be mounted on the same blocks as the switch for the lights and located near the head of the berth. Push-buttons at tables shall be of the pear-push type, the cords to lead from ceiling buttons; cup hooks to be conveniently placed for hanging the bights of the cords. Push-buttons for voice tubes will be located, if practicable, directly over or under the mouthpiece.

TELEGRAPH AND INDICATOR CIRCUITS.

179. When rheostats are used (for the purpose of using the dynamo current) the binding posts to which the connections are made will be equidistant from the ends, and protect the circuit from exposure to the full dynamo potential.

ENGINE TELEGRAPH.

180. A transmitter for each engine-room will be installed on the bridge (in the chart-house and in the conning tower, if directed), with receivers in each engine-room and necessary return transmitters and receivers as may be necessary to the particular device. Standard action cut-out switches are to be placed on the circuits leading to the bridge and chart-house.

HELM TELEGRAPH.

181. A transmitter to be located on the bridge, in the chart-house and in the conning tower. Receivers will be provided in the tiller-room, steering engine-room and at the wheels aft. Standard action cut-out switches are to be placed on the circuits leading to the bridge, chart-house and wheels aft.

ENGINE-REVOLUTION AND DIRECTION INDICATORS.

182. The transmitters to be in the shaft passages; in vessels not provided with shaft passages (or alley) to be located as far aft as possible. Receivers to be located in the engine-rooms, conning tower, chart-house and on bridge. Standard action cut-out switches are to be placed on the circuits leading to the chart-house and bridge.

HELM INDICATORS.

183. The transmitter to be located in the tiller-room. Receivers to be located in the steering engine-room, conning tower, chart-house, on the bridge and at the wheels aft. Standard action cut-out switches are to be placed on the circuits leading to the chart-house, bridge and wheels aft.

FIRE-ALARM CIRCUIT.

184. The annunciators to be located in the dynamo-room unless otherwise directed. The thermostats to be placed in metal cases overhead in such storerooms as shall be directed, and overhead and on bulkheads in all bunks. All thermostats in any one compartment to be connected in parallel.

GENERAL-ALARM CIRCUITS.

185. The gongs are to be so located in the living and working spaces as to be heard by all the ship's force. The gongs are to be operated by contact makers located in the chart-house, conning tower and the state-rooms for the captain and executive officers. All contact makers are to be placed at a distance from the push-buttons, to prevent mistake.

INSTALLATION OF RANGE-FINDERS.

1. The wiring to be the standard cable. The leads to be run below protective deck, or where protected by armor, and run in conduit or

molding corresponding to the use of conduit or molding for the lighting circuits in the location. Water-tightness to be insured, and effected as prescribed for those circuits. The range-finder circuit will receive its current for the *battle-service* circuit, the connection to be made with a standard No. 14 B. & S. G. conductor, the conductor to be connected to a rheostat; the range-finder circuit to be taken from interior binding posts on the rheostats, to protect the circuit from the full voltage of the *battle-service* circuit. The rheostats are to be designed to provide current for both range-finder and range-finder telephone circuits.

187. The installation of all electrical apparatus for interior communications not mentioned in these specifications shall be under the direction of the Bureau of Equipment and according to specifications prepared by the Bureau as to material, apparatus and method of installation. All to be subject to approval.

INSTALLATION OF ELECTRIC OPERATORS FOR STEAM WHISTLES AND SIRENS.

188. The clockwork mechanism will be placed in the chart-house on one of the bulkheads, as directed. The connection to the signal circuit will be made with No. 14 B. & S. lighting conductors in lighting wire conduit and molding through a double pole switch to a branch junction box three-way. The connection to the controlling switch on the bridge is to be made with the standard whistle cable, triple conductor. The connection to the cable coupling case at the magnet case is to be made with the standard whistle cable, double conductor. Inside of the chart house the cables will be run in interior-communication molding. From the bridge deck to the rail a special deck tube will be used. The run from the cable coupling case to the desk of bulkhead will be made in conduit, ending in a flange. In going through the hood around the stack an angle flange will be used. The conduit will be secured to the stack at about every four feet by pipe supports. A sleeve expansion joint is to be placed in the conduit, between the cable coupling case and the upper support, to provide the increased length of the conduit required to accommodate for the expansion of the heated steam pipe leading to the whistle. The electric-whistle operator and signal system is to be fitted with accessories for proper installation as shown in the Bureau's drawing No. 809 H., and connected as per Bureau's drawing No. 811 A.

189. When the installation is complete, and before acceptance, the insulation resistance of all circuits must be tested out, and conform to the following specifications: *Circuits for continual service, battle service, general service, sea service and day service* must be connected up to all their outlets and show an insulation resistance of not less than 1 megohm between circuits, and from each circuit to ground. Search-light feeders and motor feeders must show an insulation resistance of not less than 5 megohms, the circuits not being connected up. The signal circuit will conform to the test for search-light feeders. The generating sets, wiring appliances, fixtures and accessories to pass the tests required by their respective specifications.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE SECONDARY BATTERY.

By LIEUT. F. K. HILL, U. S. Navy.

During the late war with Spain the writer was on the Iowa and had command of the secondary battery on the upper deck—sixteen 6-pounders and two 4-inch R. F.

So much has been written, in a popular way, of the merits of secondary battery, and there has also been so much talk on the subject, from which erroneous conclusions (in the writer's opinion) have been drawn, that the writer has thought to give his views from deductions made after seeing the battery under service conditions.

It was a general opinion in the Navy that since no good range-finder had been developed the secondary battery might be used for this purpose, and much has been written on the subject. It was found in actual service that against forts or in fleet action these guns could not be thus used, because, in the great number of shots delivered, those of a particular ship or of a particular gun could not be located, and therefore no range could be determined by an individual gun or group of guns. In action between two ships the secondary battery might, under some circumstances, be used as a range-finder, but it is the writer's belief that since the larger guns will begin an action they certainly will never stop firing to allow the smaller guns to get the range, and the range cannot be determined by a small gun unless the larger guns cease firing.

In the bombardment of forts at San Juan, Captain Evans soon saw that the secondary battery was making no impression, although the number of hits was great, so he ordered the small guns to cease firing, and from that time on the 6-pounder guns were not again used against forts.

July the 3d was the day on which the secondary battery in the popular mind came to the front, and yet if this action be carefully analyzed the secondary battery will not be so important as we are led to believe from common report. The secondary batteries of the large ships did what they were called on to do in the case of the torpedo destroyers, and that was legitimate and complete work in their line.

The secondary batteries of the large ships also did most of the damage to the four armored cruisers. Yet, does it follow from this that the main batteries should be reduced in number or size? The writer thinks not, for the following reasons:

1. The Spanish ships were whipped so quickly that there was no time to develop the ultimate fighting strength of our vessels
2. The Spanish vessels were loaded with wood, and their destruction was due secondarily to this fact, as fire was an important feature in their destruction.
3. The Spanish gunners did no good shooting, so that our service of the secondary battery guns was never materially interfered with.

For these reasons the writer thinks that if the battle had been between two fleets of battleships, practically non-inflammable with good gunners on both sides, the first part of the action would have seen the mutual destruction of the secondary batteries and crews, and the final test would have been between the heavy guns and the armor.

Therefore, let us not be led away by an accidental victory of small guns and say that we should have more rapid-firing guns and a reduction of the main battery, but rather let us keep on in our former paths with big ships and big guns, and let the little ones keep their place as *secondary*, for *secondary* they certainly are

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NAVAL RESERVES AND NAVAL VOLUNTEERS.

By LIEUTENANT R. C. SMITH, U. S. Navy.

To naval readers it is not necessary to expatiate on the experiences of Naval Reserves in the late war. The fleet was largely increased and it was necessary to man it. The one-year's men helped out materially, but they were not numerous enough to meet all requirements. As a result the Naval Reserves were utilized in the general service. It is known that they were not altogether satisfactory; it could not be expected that they should be; but on the whole they filled positions that would have been otherwise vacant, and some of them did very good work. The navy is indebted to them, and they should be made to feel it. The writer served a couple of months with a large contingent of them aboard an auxiliary cruiser. Actual hostilities had ceased at the time, and it was possible to observe these men after the excitement of war had subsided. They were intelligent and patriotic, and while all were not sailors, they did their work creditably. To have become the equal of man-of-war's men they would have had to continue permanently in the service. This of course was out of the question. But I often reflected that with their capacity and local organization and the time they could ordinarily command for drill and instruction, there were one or two specialized duties of real importance to the navy in the discharge of which they could be made actual experts.

The Government felt that much of the trouble of the Reserves was due to lack of uniformity in organization, drill and instruction. But as this will always be the case when there is no governmental supervision or control, the remedy seemed to lie in enrolling and training a reserve that could be called on with

confidence in emergencies like the one that lately confronted us; at least such is the impression I have gained from newspaper reports and the bill for enrolling a reserve now before Congress. This bill seems to follow the able report made by Lieutenant Southerland to the Assistant Secretary of the Navy. It is to be hoped it will pass, as it will accomplish a great deal of good in the right direction. It seems unfortunately to have aroused opposition in some quarters. I am not in a position to know if this will prove serious. I have had talks with a few reserve men, and the ground seems to be that the tendency will be to disrupt the local organizations. This of course would not be desirable, as the local training is of great importance in supplementing any drill and instruction that can be included in a government scheme.

The problem then is to encourage the local organizations as an important adjunct to the governmental enrollment. Any opposition that exists to the enrollment comes from that section of the present Naval Reserves, the individuals of which feel that they are not deep-sea sailors and do not desire to bind themselves to serve anywhere and at any duty to which the government may see fit to order them. When it is considered that the non-sailor element is largely in the majority in the Naval Reserves, it is seen that there are possibilities here of a serious complication.

There are, generally speaking, two classes of men available for re-enforcing the navy in time of war; men with previous nautical training and men without it, or with very little. If the former class was numerous enough to fill all the requirements the question would be simple enough; but it is well known that this is not the case. The numbers of available seamen are not nearly adequate to the navy's needs in time of war. Fortunately, of the other class there are many men of nautical inclination and some knowledge of the water who are ready at the call to war to render any service that lies in their power. Since it is impossible to obtain all the seamen that would be desirable, it will be decidedly to the interest of the navy to make use of these other men also. And to get the best results from their services, it will be necessary to determine in advance the character of their work, train them for it, and when war breaks out assign them to it. If to assure the success of the seaman reserve movement it is necessary to provide government supervision and control;

equally will it be necessary for the government to supervise and control the non-seaman organization and management.

To divide these classes again on slightly different lines, there are men who are ready in time of war to serve the country anywhere and on any duty, and there are men who are unable for various reasons to do this, but who would be glad to serve locally in such capacity as they could. As the national reserve will be composed of the former class alone, some other provision will be required to ensure the services of the latter class. Here seems a fitting place to draw a distinction between the two general classes referred to above. The term naval reserve has been used rather loosely since the incipency of the movement. To make a distinction some State organizations have been called naval militia. The difference is this: The ordinary meaning of a reserve of anything, whether of force, or of men, or of money, is something held back, but available and ready for use in an emergency. Under this definition a true reserve would be composed of seamen alone, or of men with sufficient nautical and naval training to step aboard the man-of-war, settle down in their places, and thenceforth be to all intents and purposes a part of the regulars. This, I take it, is the scope of the present national reserve movement. As such it is a splendid thing and deserving of success.

The so-called State reserves were usually not reserves at all, that is, referring to perhaps nine-tenths of their membership; and this was the reason for the adoption of the term naval militia. It is an improvement on naval reserve in the meaning conveyed, though still open to objections. Militia in its derivation suggests soldiers; and though in the present day the naval service is said to be a military service, it seems good to stick to its own designation. To make a general distinction between the two classes why not limit the use of the term reserve to the seaman class alone, and characterize all the other available elements as naval volunteers? The term volunteer has sometimes been applied to the one-year's men, but without any real necessity, as these latter were regularly enlisted in the rates they were qualified to fill, the only distinction being in the term of service. Volunteer has in it something of the suggestion of amateur, which is very much the meaning to be conveyed. The men designated are mostly amateur sailors, and in war would be serving the

country for love and patriotism, or for the love of adventure; the result is the same.

The national reserve then takes cognizance of men who are sailors and have served aboard the man-of-war; or if they have not, can still be given sufficient training in peace time to make them useful and available in war for the regular duties of the blue-jacket afloat. Can not we also by additional legislation take cognizance of the men of nautical inclination and some local knowledge of the water who would be glad to serve their country in special directions and near their homes to the best of their abilities, the men whom it has been suggested above to call naval volunteers? Perhaps they also could be enrolled in a national organization after demonstrating their fitness in certain branch which will be considered later. The national reserves and the national volunteers could then serve side by side in the same local organizations with mutual benefit. In time of war, the reserves would be called away, but the volunteers would continue under governmental control the same general work they had been drilled at in time of peace, and as far as possible under their own officers and organization. Rank, pay and privileges could be made equivalent in the two branches. It is perfectly possible that men qualified to serve in the reserves might for various reasons prefer the volunteers, or a volunteer might perfect himself and be able to pass an examination as a reserve. Men satisfactorily qualified could well be permitted to transfer from one branch to the other under suitable limitations.

While I do not propose in this paper to consider fully the employment of the naval volunteers, it is perhaps desirable to enumerate some of the duties to which they might appropriately be assigned. The reconnoissance of the coast and pilotage of the harbors and inland waterways, the preparation of war maps, the coast signal service, including the pigeon-messenger service, the mining and patrolling of the harbors, and the torpedo-boat service for local defense are all duties which it would be the policy to turn over to them at once.

For the reconnoissance of the coast there would be needed few small craft of various kinds. A converted yacht in each district would be a good beginning. In addition, there should be one or two steam launches and several cutters. Records would be kept and the results of the work noted on the war maps as

charts. A knowledge of local pilotage would necessarily follow. The work would be directed entirely by the local organizations, but on a plan devised by the government and uniform for all districts. An annual report would be made of the results, and such portions published as were not confidential. A rivalry would thus result between the various districts to excel in the amount and quality of the work.

The present State organizations are already familiar with navy signaling. Under a central direction coast signal stations would be established at various points and manned entirely by the local volunteers. Practice would be undertaken with sufficient frequency to keep the men proficient. Telegraphy and the care of telegraph and telephone circuits would be a part of the requirements. Recruits for this branch could very readily be found. The pigeon-messenger service would fall naturally under the same central management. Distributed about the country are numerous clubs and private individuals interested in pigeon flying. They should be encouraged to join a national organization and perfect a plan in time of peace whereby pigeon cotes suitably located and an ample supply of trained birds could be at hand when wanted.

The mining of our harbors is now by law in the hands of the army engineers, though in most foreign countries these duties, with reason, devolve on the navy. The sailor's knowledge of boats and tides, and the fact that he must be trained in submarine mining in order to make use of it in operations on the enemy's coast, are sufficient reasons for giving him control of the system in our own waters. Added to this, that the mines are intended for use against hostile shipping, and that the sailor is familiar with the ways of ships and can often anticipate their movements and thus locate the mines in the most advantageous positions, and the case seems clear for the navy.

Here, indeed, is a field for our naval volunteers. With the large and growing knowledge of electricity, and of the handling and manipulation of electrical cables and telephone circuits, recruits for this branch of work could be had with ease. It is interesting to note that these were the men in demand by the army engineers for mining our harbors in the war just passed. It will be much better to train them in peace times for the requisite duties. With the knowledge of the water that every

resident of a seaport acquires in youth, and with instruction : stated intervals by officers of the regular service, these men would become actual mining experts, and their services would be of the greatest value to the government. The same men would compose the harbor patrol, the chief duty of which is regulating the traffic of the harbor and enforcing the rules relating to the channels through the mine fields. I believe there were disagreements on these points during the war, mainly by reason of the divided control.

But perhaps the most valuable, interesting and attractive work of any would be in connection with the local torpedo-boat defense system with which this country must surely very soon be provided. We know that, generally speaking, torpedo-boats are of two classes—destroyers, designed to accompany fleets, and the smaller coast defense boats operating from fixed bases. The destroyers would, as now, be officered and manned from the regular service, as would a certain number of the more seaworthy of the smaller boats, capable, as circumstances permitted, of keeping touch with the fleet in its operations near the coast. But of the remainder, there must be eventually a certain number stationed permanently at each prominent port on our coast. The regulars of the navy could not man all of these if they wished to. Who other than the local naval volunteers can possibly form the *personnel* of this service? The alternative will be in laying out the boats in large numbers, against which permanent practice should like to register a most earnest protest. They must, of course, be laid up in the winter season at our northern seaports and some will always be under repair; but with these exceptions they should be kept for the greater part continually in use. The training of a crew for effective work requires weeks of practice and if some twenty odd officers and men are sent to launch a boat from the ways, get up steam and go out to look for the enemy, they are going to meet with ignominious failure should they come up with him in the first few days.

To organize a permanent local service we must look for these requirements. The officers and men must be watermen, if not deep-sea sailors. They must have a good knowledge of the pilotage of all harbors, bays, inlets, inland waterways and shoal channels in their own district. They must be of a mechanical turn of mind to appreciate the machinery of the boat and the

mechanism of the torpedo. These are the requirements, and it is easily seen that they can be met by material now in the present State organizations. The perfection of the material depends on practice; and as to that, if the boats should be made available, they would be in use by the different crews every long summer afternoon as a welcome respite from routine office or machine shop work.

The districts would be in command of regular officers, and there would have to be enough instructors and torpedo experts to keep the work moving. The boats themselves could be eventually officered and manned entirely from the naval volunteers, under whose care they would be hauled out and laid up in winter.

I have thus tried to show that there is work for a corps of naval volunteers as well as for the reserves. Of course, all of this work could be done by reserves if enough of them could be got together. But it does not seem likely that there will be more than enough for many years to fill up the war complement of the fleet. Therefore it becomes a necessity to utilize men who can acquire a working knowledge of various specialties but who are in no sense man-of-war's men, and therefore cannot form part of a true reserve.

The reserves and volunteers would have no trouble in coming together in the local organizations, and would, indeed, derive mutual benefit from the contact. If reserves alone are enrolled and the State organizations are still maintained, there must be inevitable bickerings between the members who do and those who do not belong to the national organization. By enrolling the volunteers also, it is probable that all cause for friction would disappear, and the local organizations would be stimulated and encouraged as never before. A man then with any nautical skill or liking, however slight, and with any mechanical or sailor-like knowledge up to that of the trained man-of-war's man, can find a place where he will fit in, and can count on being employed in time of war on a duty with which he is familiar, a consideration which it seems to me must be the beginning of any success in organizing the auxiliary navy.

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VIEWS OF ADMIRAL CERVERA REGARDING THE
SPANISH NAVY IN THE LATE WAR.

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INTRODUCTORY.

Under the title "Vindication of the Navy," there appeared in the *La Epoca*, Madrid, November 5, 1898, this article, which is made up mainly of extracts from letters from Admiral Cervera, written previous to the declaration of war and continued to May 5. These letters were written by Admiral Cervera in protest against Spain rushing into war in face of certain defeat, due to the naval strength of the United States and the unpreparedness of the Spanish navy.

Cervera writes: "I ask myself if it is right for me to keep silent, and thereby make myself an accomplice in adventures which will surely cause the total ruin of Spain. And for what purpose? To defend an island which was ours but belongs to us no more, because even if we should not lose it by right in the war, we have lost it in fact, and with it all wealth and an enormous number of young men, victims of the climate and bullets, in the defense of what is now no more than a romantic ideal. Furthermore, I believe that this opinion of mine should be known to the Queen, and by the whole counsel of ministers.

" . . . If our correspondence of the last two months is looked over it will be seen, not that I have been a prophet, but that I have fallen short of the true mark. Let us not have any illusions as to what we can do. . . .

"I have deemed it my duty to express my opinions to the proper authorities clearly and without beating about the bush. Now, let order be given to me; I will execute it with energy and decision, and am ready for the result."

Spain had neglected her navy, and Cervera shows it was imprudent for her to attempt war against a superior naval power.

RICHARDSON CLOVER,
Chief Intelligence Officer.

NAVY DEPARTMENT,
OFFICE OF NAVAL INTELLIGENCE,
Nov. 29, 1898.

THE VINDICATION OF THE NAVY.

(From *La Epoca*, Madrid, November 5, 1898.)

The first judgment of a part of the public concerning the conduct of the navy in the combats of Cavite and Santiago has been already much modified. In the face of the evidence of official reports; of the praises and expressions of respect and admiration of the victors toward those who fought against them under disadvantageous circumstances; of the technical explanations given by foreign and Spanish scientific authorities, the unjust accusation of the first few days have faded away.

But still more complete must be the vindication of the navy which has been treated with unjust severity and manifest partiality, when justice compels us to acknowledge that in all the even of the war the navy has done all that could be asked of it, considering its limited means; and that not only has it done its duty in naval actions, but it has also assisted the action of the land forces, as for instance in Santiago, now mounting and serving the batteries, which made it possible to prolong the resistance of the city; now landing its crews and fighting in the trenches so heroically that it was these naval forces that suffered the greatest losses.

As regards Admiral Cervera and his conduct from the time he took command of the fleet until the terrible battle of Santiago we feel sure that not only will the supreme council of war and the marine recognize that he carried the fulfillment of duty to the last possible extreme, but also that public opinion will have atoned to him for the injustice with which he has been treated, and will surround him with the respect deserved by those who, subordinating every consideration to the love of their country, point out to those who were blind the abyss toward which they were conducting the nation. His advice and representations were not heeded, and he heroically complied with the law of obedience under which are all who wear the honorable military uniform.

We will not refer, for the present, to the battle of Santiago, which is now *sub judice*, but full light will be thrown upon this subject in due time. But previous events demonstrate the forethought of Rear-Admiral Cervera and the lamentable blindness of those who would not hear him, and are sufficient for the vindication of the sailors of Santiago.

From documents known by many chiefs and officers of the navy it appears that Admiral Cervera expressed himself always ready to give absolute obedience to the orders of the government; that he pointed out the dangers of a disastrous war with the United States while it was still possible to avoid it; that he repeatedly reported the deficiencies in the vessels under his command; that he persistently offered to come to Madrid to explain to the council of ministers the reasons why our fleet was going to certain destruction; that he was not allowed to explain these reasons to those about to take upon themselves the enormous responsibility of this war; that he was forced to sail without a war plan, against his opinion and that of all the commanders of the fleet, who signed a solemn protest declining the responsibility of the consequences; that finally many of the elements indispensable to put the ships in a fair condition were not supplied to him; that the Colón sailed without her turret artillery, and some of the Bilbao cruisers with some of the pieces and ammunition defective, and at least one of them with her speed very much reduced on account of the state of her bottom.

Though they possessed such conclusive and justifying documents, those officers had the self-denial, the patriotism, and the spirit of discipline not to reply to the attacks made against them, thus setting a fine example which is very rare in these times of personal and corps egotism, general insubordination, and wild passions. This noble conduct makes it still more necessary to give full satisfaction to the navy by making public, when the Cortes meet, all the official correspondence exchanged between Admiral Cervera and the minister of marine, as well as the supplementary private documents bearing on the subject.

We have had occasion to see some of these documents, and we wish to anticipate that justification, and to show that in reality it was not Cervera who lost the fleet, but those who, against the opinion of the Admiral and the commanders of the fleet, without even hearing Cervera's representations, sent the vessels to fight

under such conditions that they *had* to perish, thus sacrificing to the vain and noisy outcry of our jingoes the best vessels of Spain and the lives of hundreds of brave men.

Present circumstances prevent us, at this time, from making known much interesting data. However, the following is quite sufficient, we believe, to form a more just opinion of our navy.

In January, 1898, Admiral Cervera wrote to one of his relatives:

DEFICIENCIES OF THE NAVAL INDUSTRY.

"About two years ago I wrote you a letter concerning our condition to go to war with the United States. I requested you to keep that letter in case some day it should be necessary to bring it to light in defense of my memory or myself when we had experienced the sad disappointment prepared for us by the stupidity of some, the cupidity of others, and the incapability of all, even of those with the best of intentions.

"To-day we find ourselves again in one of those critical periods which seem to be the beginning of the end, and I write you again to express my point of view and to explain my action in this matter, and I beg you to put this letter with the other one, so that the two may be my military testament.

"The relative military positions of Spain and the United States has grown worse for us, because we are extenuated, absolutely penniless, and they are very rich, and also because we have increased our naval power only with the Colón and the torpedo-destroyers, and they have increased theirs much more.

"What I have said of our industry is sadly confirmed in everything we look at. There is the *Cataluña*, begun more than eight years ago, and her hull is not yet completed. And this when we are spurred on by danger, which does not wake patriotism in anybody, while jingoism finds numerous victims, perhaps myself to-morrow. And the condition of our industry is the same in all the arsenals.

"Let us consider, now, our private industries. The *Maquinista Terrestre y Marítima* supplies the engines of the *Alfonso XIII*; Cadiz the *Filipinas*. If the *Carlos V* is not a dead failure, she is not what she should be; everything has been sacrificed to speed, and she lacks power. And remember, that the construction is purely Spanish. The Company of *La Graña* has not completed its ships, as I am told. Only the *Vizcaya*, *Oquendo* and *Maria*

Teresa are good ships of their class; but, though constructed at Bilbao, it was by Englishmen. Thus, manifestly, even victory would be a sad thing for us. As for the administration and its intricacies, let us not speak of that; its slow procedure is killing us. The Vizcaya carries a 14-cm. breech-plug which was declared useless two months ago, and I did not know it until last night. And that because an official inquiry was made. How many cases I might mention! But my purpose is not to accuse, but to explain why we may and must expect a disaster. But as it is necessary to go to the bitter end, and as it would be a crime to say that publicly today, I hold my tongue, and go forth resignedly to face the trials which God may be pleased to send me. I am sure that we will do our duty, for the spirit of the navy is excellent; but I pray God that the troubles may be arranged without coming to a conflict which, in any way, I believe would be disastrous for us."

STATE OF THE FLEET.

In the beginning of February Admiral Cervera wrote to a high official personage:

"Although I am sure that I am telling you nothing new, I think it is not idle, in these critical times, to make a study of the condition of the fleet. We must discount the Alfonso XIII, so many years under trials that it appears we shall not have the pleasure ever to count it among our vessels of war. The fleet is reduced to the three Bilbao cruisers, the Colón, the Destructor, and the torpedo-destroyers Furor and Terror. The three Bilbao battle-ships are practically complete, but the 14-cm. artillery, the main power of these vessels, is practically useless, on account of the bad system of its breech mechanism, and the bad quality of the cartridge cases, of which there are only those on board.

"The Colón, which is undoubtedly the best of all our ships from a military point of view, has not received her guns. The Destructor may serve as a scout, although its speed is not very high for this service in the fleet. The Furor and Terror are in a good condition, but I doubt if they can make effective use of their 75-mm. pieces. As for the supplies necessary for a fleet, we frequently lack even the most necessary. In this arsenal (Cadiz) we have not been able to coal, and both at Barcelona and Cadiz we could only obtain half of the biscuit we wanted, and that only because I had ordered 8,000 kilos to be made here. We

have no charts of the American seas, although I suppose that they have been ordered; but at the present time we could not move. Apart from this deficient state of the material, I have the pleasure to state that the spirit of the *personnel* is excellent, and that the country will find it all that it may choose to demand. It is a pity that a lack of better and more abundant material, greater supplies, and less hindrances are wanting to put this *personnel* in a condition to amply carry out its rôle!"

"I note," said the Admiral in another letter, "what I am told concerning the heavy artillery of the Colón. It is to be very much regretted that there is always so much underhand work about everything, and that there should be so much of it now regarding the acceptance of the 254-mm. guns, because if we finally take them, it will seem that we are yielding to certain disagreeable impositions, and if things come to the worst, it seems to me we will have to accept, as the proverb says, 'hard bread rather than none'; and if we have no other guns, and these ones can fire at least 25 or 30 shots, we will have to take them anyhow, even though they are expensive and inefficient. And we must not lose time, so that the vessel may be armed and supplied with ammunition as soon as possible."

Some time afterwards, when matters were getting worse and worse, the Admiral was more explicit still. Shortly after the Dupuy de Lome incident he said:

"I do not know when the Pelayo and Carlos V will be able to join the fleet, but I suspect that they will not arrive in time. Of the first one I know nothing at all, but I have received some news concerning the second one, and certainly not very satisfactory as regards the time it will take for it to be ready. It seems to me that there is a mistake in the calculation of the forces we may count upon in the sad event of a war with the United States. In the Cadiz division I believe the Numancia will be lacking. I do not think we can count on the Lepanto. Of the Carlos V and the Pelayo I have already spoken. The Colón has not yet received her artillery, and if war comes, she will be caught without her heavy artillery. The eight principal vessels of the Havana station have no military value whatever, and, besides, are badly worn out, therefore they can be of very little use. In saying this I am not moved by a fault-finding spirit, but only by a desire to avoid illusions that may cost us very dear.

"Taking things as they are, however sad it may be, it is seen that our naval force when compared with that of the United States is approximately in the proportion of 1 to 3. It therefore seems to me a dream, almost a feverish fancy, to think that with this force, extenuated by our long wars, we can establish the blockade of any port of the United States. A campaign against them will have to be, at least for the present, a defensive or a disastrous one, unless we have some alliances, in which case the tables may be turned. As for the offensive, all we could do would be to make some raids with our fast vessels in order to do them as much harm as possible. It is frightful to think of the results of a naval battle, even if it should be a successful one for us, for how and where would we repair our damages? I, however, will not refuse to do what may be judged necessary, but I think it convenient to analyze the situation such as it is, without cherishing illusions which may bring about terrible disappointments."

COMPARISON OF THE FLEETS.

The comparison of both navies, based upon the studies made in prevision of a war with the United States, suggested to the Admiral the following considerations on February 25, 1898:

"If we compare the navy of the United States with our own, counting only modern vessels capable of active service, we find that the United States have the battle-ships Iowa, Indiana, Massachusetts, Oregon and Texas; the armored cruisers Brooklyn and New York; the protected cruisers Atlanta, Minneapolis, Baltimore, Charleston, Chicago, Cincinnati, Columbia, Newark, San Francisco, Olympia, Philadelphia, and Raleigh, and the rapid unprotected cruisers Detroit, Marblehead, and Montgomery. Against this we have, following the same classification, the battle-ships Pelayo, Infanta Maria Teresa, Vizcaya, and Oquendo, armored cruiser Colón, and protected cruiser Carlos V, Alfonso XIII, and Lepanto; no fast unprotected cruisers; and all this supposing the Pelayo, Carlos V, and Lepanto to be ready in time, and giving the desired value to the Alfonso XIII. I do not mention the other vessels on account of their small military value, surely inferior to that of the nine gunboats, from 1,000 to 1,600 tons each, six monitors still in service, the ram Katahdin, the Vesuvius, and the torpedo-boats and destroyers,

which I do not count. I believe that in the present form the comparison is accurate enough.

"Comparing the displacements, we find that in battle-ships United States have 41,589 tons against our 30,917 tons; in armored cruisers they have 17,471 tons against our 6,840; in protected cruisers 51,098 against 18,887, and in fast unprotected cruisers they have 6,287 and we none. The total of vessels for all kinds of operations comprise 116,445 tons against 56 tons, or something less than one-half.

"In speed our battle-ships are superior to theirs, but not their armored cruisers. In other vessels their speed is superior to ours.

"Comparing the artillery, and admitting that it is possible to fire every ten minutes the number of shots stated in the respective reports, and that only one-half of the pieces of less than 20 inches are fired, and supposing that the efficiency of each shot of the calibers 32, 30, 28, 25, 20, 16, 15, 14, 12, 10, 17.5, 5.7, 4.7, and 3 inches is represented by the figures 328, 270, 220, 156, 80, 41, 33, 27, 10, 4, 2, and 1, which are the hundredths of the cubes of numbers representing their calibers expressed in centimeters $\left(\frac{\text{caliber in cm.}^3}{100}\right)$, we find that the artillery power of the American battle-ships is represented by 43,822, and that of ours by 29,449; that of the American armored cruisers by 13,550, that of ours (Colón) by 6,573; that of the American protected cruisers by 62,725, and that of ours by 14,600; that of the American unprotected cruisers by 12,300. Therefore, according to these figures, the offensive power of the artillery of the United States vessels will be represented by 132,397, and that of the Spanish by 50,622, or a little less than two-fifths of the enemy's.

"To arrive at this appalling conclusion I have already said it has been necessary to count the Pelayo and Carlos V, which probably will not be ready in time; the Lepanto, which surely will not be ready, and the Alfonso XIII, whose speed renders her of a very doubtful utility.

IMPOSSIBILITY OF AN OFFENSIVE CAMPAIGN.

"Now, to carry out any serious operations in a maritime war the first thing necessary is to secure control of the sea, which can only be done by defeating the enemy's fleet, or rendering it

powerless by blockading them in their military ports. Can we do this with the United States? It is evident to me that we can not. And even if God should grant us a great victory, against what may be reasonably expected, where and how would we repair the damages sustained? Undoubtedly the port would be Havana, but with what resources? I am not aware of the resources existing there, but judging by this department, where everything is scarce, it is to be assumed that the same condition exists everywhere, and that the immediate consequences of the first great naval battle would be the enforced inaction of the greater part of our fleet for the rest of the campaign, whatever might be the result of that great combat. In the meantime the enemy would repair its damages inside of its fine rivers, and aided by its powerful industries and enormous resources. This lack of industries and stores on our part renders it impossible to carry on an offensive campaign.

"If the control of the sea remains in the hands of our adversaries, they will immediately make themselves masters of any unfortified port which they may want in the island of Cuba, counting, as they do, on the insurgents, and will use them as a base for their operations against us. The transportation of troops to Cuba would be most difficult and the success very doubtful, and the insurrection, without the check of our army, which would gradually give way, and with the aid of the Americans, would rapidly increase and become more formidable.

"These reflections are very sad; but I believe it to be my unavoidable duty to set aside all personal considerations and loyally to represent to my country the resources which I believe to exist, so that, without illusions, it may weigh the considerations for and against, and then, through the government of His Majesty, which is the country's legitimate organ, it may pronounce its decision. I am sure that this decision will find in all of us energetic, loyal, and decided executors. Our motto is 'the fulfillment of duty.'"

MORE DEFICIENCIES—THE COUNTRY MUST BE TOLD THE TRUTH.

On February 26 the Admiral wrote the following:

"When I received yesterday the letter in which, among other things, you asked me if the Colón could go out for target practice, I answered that the vessel was ready, and at the same time I took measures so that the cartridge cases which might be used in that

practice should be recharged, but it appears that there is no furnace in which they can be reannealed, or a machine to reform the cartridge cases. The extra charges which the vessel brought (72 per gun) are therefore useless.

"I send to-day the official letter which I announced yesterday. Its conclusions are indeed afflicting, but can we afford to cherish illusions? Do we not owe to our country not only our life if necessary, but the exposition of our beliefs? I am very uneasy about this. I ask myself if it is right for me to keep silent, and thereby make myself an accomplice in adventures which will surely cause the total ruin of Spain. And for what purpose? To defend an island which was ours but belongs to us no more, because even if we should not lose it by right in the war, we have lost it in fact, and with it all our wealth and an enormous number of young men, victims of the climate and bullets, in the defense of what is now no more than a romantic ideal. Furthermore, I believe that this opinion of mine should be known by the Queen, and by the whole council of ministers."

That this thoughtful and patriotic advice was not favorably received by the government is shown by the following letter a few days afterwards:

"Yesterday I received your letter of the 28th, and I regret very much the painful impressions caused by my remarks; but I am not surprised, because they are truly sad, and still, perhaps, they fall beneath the mark, judging from anything one sees. Just now we have another proof of this in the fact that the difficulty of obtaining cartridge cases for the Colón arises from the want of means (money), and this on the eve, perhaps, of a war against the richest nation in the world. I do not wish to dwell too much on this point, for no practical result could be obtained. But every detail points out either our lack of means or our defective organization, and, above all, our utter lack of preparation.

"I have deemed it my duty to express my opinions to the proper authorities clearly and without beating around the bush. Now let orders be given to me; I will carry them out with energy and decision. I am ready for the worst."

MORE DATA REGARDING OUR INFERIORITY—DANGER TO THE PHILIPPINES.

"An examination of our forces," said the Admiral on March 25, "based upon what I already know and upon recent informa-

tion and observation, not only confirms what I said, but shows it to be still worse. I have visited the Vitoria, on which I counted, and from my visit I have drawn the conviction that we can not count on her for the present conflict. Neither does my information permit me to count on the Pelayo, Carlos V, or Numancia. And yet, as this opinion is not based upon personal observation, I include them in the enclosed statement. Whatever may be the direction given to the conflict, either war, negotiations direct, or through a third party, an arbitrator or otherwise, the longer the decision is delayed the worse it will be for us. If it is war, the longer it takes to come the more exhausted we will be. If it is negotiation of any kind, the longer it is postponed the greater will be the demands, each time more irritating, which will be presented by the United States, and to which we will have to yield in order to gain time in the vain hope of improving our military position. And as our position can not be improved, let us see what we can expect from a war under such conditions.

"It would be foolish to deny that what we may reasonably expect is defeat, which may be glorious, but all the same, defeat, which would cause us to lose the island in the worst possible manner. But even supposing an improbability, that is, that we should obtain a victory, that would not change the final result of the campaign. The enemy would not declare itself defeated, and it would be foolish for us to pretend to overcome the United States in wealth and production. They would recover easily, while we would die of exhaustion, although victorious, and the ultimate result would be always a disaster. Only in case we could count on some powerful ally could we aspire to obtain a satisfactory result.

"But, besides having to discount the high price to be paid for such an alliance, even then we would only be postponing the present conflict for a few years, when it would become graver than it is to-day, as is the present insurrection in comparison with the last.

"Even admitting the possibility of retaining Cuba, this island would cost us enormous sacrifices by the necessity of being constantly armed to the teeth. And here the problem already pointed out by somebody arises: Is the island worth the ruin of Spain? (Silvela in Burgos.) I do not speak on the subject of privateering, because it seems to me that no man acquainted with history

can attach any value to privateering enterprises, which nowadays are almost impossible on account of the character of modern vessels.

"The accompanying statement shows that our forces in the Atlantic are approximately one-half of those of the United States both as regards tonnage and artillery power. I have never thought of the forces which the United States have in the Pacific and Asia in connection with the development of events in the West Indies; but I have always considered these forces a great danger for the Philippines, which have not even a shadow of a resistance to oppose to them. And as regards the American coasts of the Pacific, the United States have no anxiety about them. I think you are mistaken in believing that during the month of April our situation will change. As I have said above, I am sure that neither the Carlos V, the Pelayo, the Vitoria, or the Numancia will be ready, and nobody knows how we will be as regards 14-cm. ammunition. It seems sure that by the end of April the 254-mm. guns of the Colón will not be mounted. Even if I were mistaken, then our available forces in the West Indies would be 49 per cent of that of the Americans in tonnage, and 47 per cent in artillery.

"Our only superiority would be in torpedo-boats and destroyers, provided all of them arrive there in good order.

"I do not know exactly what are the sentiments of the people concerning Cuba, but I am inclined to believe that the immense majority of Spaniards wish for peace above all things. But those who so think are the ones who suffer and weep inside of their own houses, and do not talk so loud as the minority who profit by the continuation of this state of affairs. However, this is a subject which it is not for me to analyze.

"Our want of means is such that some days ago three men went overboard while manning the rail for saluting, through the breaking of an old awning line. A new line had been asked for fifty days ago, but it has not yet been replaced. In old times, forty-three days after the Hernan Cortes was laid down the vessel was at sea. It is now fifty-one days since I requested the changing of certain tubes in the boilers of a steam launch of the Teresa, and I do not yet know when it will be done. This will probably be the proportion between us and the United States in the repair of damages, in spite of our having the Havana dock, which is the

principal thing, but not all. As for the crews, I do not know them, but I may say that the crews that defeated our predecessors at Trafalgar had been recruited in the same way.

"This is my loyal opinion, and for the sake of the nation, I express it to the Government. If it is thought advisable for me to express it personally, I am ready to start at the first intimation. After I have done this, thus relieving my conscience of a heavy weight, I am quite ready to fulfill the comparatively easy duty of conducting our forces wherever I may be ordered, being sure that all of them will do their duty.

NORTH ATLANTIC SQUADRON.

SPAIN.

Protected vessel actually there, or unprotected but with a speed of over 15 miles:

	Displacement.	Artillery.
Vizcaya	7,000	6,130
Oquendo	7,000	6,130
Marques de la Ensenada	1,064	1,000

UNITED STATES.

Same kind of vessels:

New York	8,200	6,400
Indiana	10,288	9,304
Massachusetts	10,288	9,304
Texas	6,315	550
Brooklyn	9,271	7,880
Iowa	11,410	8,360
Montgomery	2,089	4,100
Marblehead	2,089	4,100
Detroit	2,089	4,100
Terror	3,600	2,896

To these may be postively added:	65,639	60,994
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SPAIN.

Infanta Maria Teresa	7,000	6,130
Cristóbal Colón	6,840	8,490*
Alfonso XIII.	4,826	4,340
	18,666	18,960

UNITED STATES.

Minneapolis	7,375	4,790
Columbia	7,375	4,790
	14,750	9,580

* Without the 25-cm. guns, the value of which is represented by 1,248.

Doubtful additions:

	SPAIN.	Displacement.	Artillery.
Pelayo		9,917	6,987
Carlos V.		9,260	5,620
		<hr/> 19,167	<hr/> 12,607
	UNITED STATES.		
Atlanta		3,000	4,270
Charleston		3,730	4,570
Chicago		4,500	4,470
Newark		4,098	6,740
Philadelphia		4,324	7,640
Dolphin		1,485	700
Yorktown		1,703	3,320
		<hr/> 22,840	<hr/> 31,710

In the South Atlantic they have:

Cincinnati	3,200	4,795
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All the other vessels have very little military value, with the exception of the torpedo-boats and destroyers, not mentioned in this statement, including the Katahdin and Vesuvius.

CERVERA WISHED TO EXPLAIN HIS OPINION TO THE COUNCIL OF MINISTERS.

Admiral Cervera's already expressed desire to personally inform the council of ministers was still more clearly expressed under date of March 16.

"Yesterday I received your favor of the day before, by which I see that our opinions agree concerning the conflict which threatens our unfortunate country. As both of us are animated by the best desires, such agreement was sure to come. It also appears that the whole government participates in this opinion, but I am afraid that there may be some minister who, while believing that we are not in favorable conditions, may have been dazzled by the names of the vessels appearing in the general statement, and may not realize how crushing a disproportion really exists, especially if he is not thoroughly aware of our lack of everything that is necessary for a naval war, such as supplies, ammunition, coal, etc. We have nothing at all. If this fear of mine is well founded, I think it is of the greatest importance that the whole council of ministers without exception be fully and clearly informed of our terrible position, so that there may not remain the least doubt that the war will simply lead us to a terrible disaster, followed by a

humiliating peace and the most frightful ruin; for which reason it is necessary not only to avoid the war but to find some solution which will render it impossible in the future. If this is not done, the more time is spent, the worse will be the final result, whether it is peace or war.

"From this reasoning, as clear as daylight to me, it appears that since we can not go to war without meeting with a certain and frightful disaster, and since we can not treat directly with the United States, whose bad faith is notorious, perhaps there is nothing left for us to do but to settle the dispute through arbitration or mediation, provided the enemy accepts. However, this order of consideration does not come within my sphere of duty, which, as the chief of the squadron, is limited to reporting the state of military affairs and then carrying out the orders of the Government. The latter, however, must be fully informed of the situation. Before dropping this subject, I must insist that perhaps it would be well for me to verbally inform the members of the Cabinet, and to say that I am ready to start at the first intimation.

"Concerning the available forces and what may be expected of them: I will be very glad if Ansaldo carries out his promise about the 254-mm. guns of the Colón. The 14-cm. cartridge cases are absolutely necessary. This vessel has only thirty, and it is to be supposed that the stores of the Oquendo and Vizcaya are not better supplied. For the present the firm is supplying only one hundred per week; and supposing that the first ones have already arrived or will arrive in Cadiz one of these days, at this rate we won't have finished until October. Then they have to be charged, therefore they can never be ready in time for the present conflict. I thought I would have the first ones by January, and I will not have them until April. The engines of the Pelayo are ready, and the vessel can sail, but how about the secondary battery and the armored redoubt? These will not be ready. If the old battery could be mounted! But I doubt it; the ports will not permit it. I have heard it said that the crew which brought the Pelayo was taken from the Vitoria, which is another proof of our excessive poverty. It will be very well if the Carlos V is soon ready, but I understand that the 10-cm. battery has not yet been mounted, and then the trials are to be made.

"I never had great confidence in the purchasing of vessels.

Too much fuss is made over every detail by ignorant people. It was through this that we lost the Garibaldi, and now we have lost the Brazilian cruisers. In fact, we have only secured the Colón, an excellent ship, but which has not yet arrived, and the Valdes. And supposing that we had everything our own way and that Providence should grant us a victory, which is highly improbable, we would then find ourselves in the condition explained in my last, and which it is not necessary to repeat. It only rests for me now to be informed of the destination of the fleet. I believe the Teresa ought to be in Cadiz, where the cartridge cases are to be recharged, and she could sail as all the guns were mounted.

"I will insist no more, but the voice of my conscience, animate by my love for my country, tells me that in saying this I am fulfilling my unavoidable duty."

CONDITION OF THE FLEET IMMEDIATELY BEFORE THE WAR.

In the month of April, shortly before the war, Cervera wrote:

"My fears are realized. The conflict is coming fast upon us; and the Colón has not received her big guns; the Carlos V has not been delivered, and her 10-cm. artillery is not yet mounted; the Pelayo is not ready for want of finishing her redoubt, and, I believe, her secondary battery; the Vitoria has no artillery, and the Numancia we had better not speak.

"But after all I am glad the end is coming. The country cannot stand this state of affairs no longer, and any arrangement will be a good one, however bad it looks, if it comes without our having to lament a great disaster, as may happen if we go to war with few half-armed vessels, and without want of means and excess of incumbrances."

A few days afterwards he wrote:

"On account of the general anxiety it is very important to think of what is to be done, so that, if the case arises, we may act rapidly and with some chance of efficiency, and not be groping about in the dark, or like Don Quixote, go out to fight windmills and come back with broken heads.

"If our naval forces were superior to those of the United States the question would be an easy one. All we would have to do would be to bar their way. But on the contrary our forces are very inferior to theirs. To endeavor to bar their way, which

could only be done by giving them a decisive naval battle, would be the greatest of follies. That would simply mean a sure defeat, which would leave us at the mercy of the enemy, who would easily take a good position in the Canaries, establish there a base of operations, crush our commerce, and safely bombard our maritime cities. It is therefore absolutely necessary to decide what we are going to do, and without disclosing our proposed movements, be in a position to act when the time comes.

"This was the substance of my telegram, and my ideas have not changed since then. If we are caught without a war plan, there will be vacillations and doubts; and, after defeat, there may come humiliation and shame."

On the eve of the war Cervera justly lamented the lack of a plan as follows:

"I regret very much to have to sail without having agreed upon some plan, even in general lines, for which purpose I repeatedly requested permission to go to Madrid. From the bulk of the telegrams received I think I see that the government persists in the idea of sending the little squadron (torpedo-boat flotilla) to Cuba. That seems to me a very risky adventure, which may cost us very dear, for the loss of our flotilla and the defeat of our squadron in the Caribbean Sea entails a great danger for the Canaries, and perhaps the bombardment of our coast cities. I do not mention the fate of the island of Cuba because I have anticipated it long ago. A naval defeat would only precipitate its ultimate loss, while if left to defend itself with its present means, perhaps it would give the Americans some annoyance. We must not deceive ourselves concerning the strength of our fleet. If our correspondence of the last two months is looked over it will be seen not that I have been a prophet, but that I have fallen short of the true mark. Let us not have any illusions as to what we can do."

The last documents relating to the sailing of the fleet from Cape Verde are the most interesting. They show what was the condition of the vessels on the 19th of April, the day before the rupture of relations. Admiral Cervera wrote from Saint Vincent, Cape Verde:

"The boilers of the *Ariete* are practically out of service, so that this vessel, instead of being an element of power, is the nightmare of the fleet. She could only be used for port defense.

The boilers of the Azor are eleven years old, and are of locomotive type. As for the Furor and Terror, their bow pl give as soon as they are in a sea way, and some of their fra have been broken. The Pluton had an accident of this l when coming from England, and had her bows strengthene Ferrol.

"I do not know whether the port of San Juan de Puerto I affords good protection for the fleet. If it does not, and if port of Mayaguez can not be effectively closed, the fleet would in a most unfavorable position. However, before forming a jment, I shall await the arrival of the Vizcaya, whose capt Eulate, is thoroughly acquainted with Puerto Rico. I am constantly preoccupied about the Canaries. It will be necessar close and fortify the port of Graciosa Island, as well as the is commanding the port of La Luz in Grand Canary.

"The idea of sending the fleet to Cuba seems to have l abandoned, I believe very wisely.

"Concerning Puerto Rico, I have often wondered wheth would be wise to accumulate there all our forces, and I do think so. If Puerto Rico is faithful, it will not be such an job for the Yankees; if it is not faithful, it will inevitably fo the same fate as Cuba, at least as regards us.

"On the other hand, I am very much afraid for the Philipp and the Canaries, as I have said before; and above all, the p bility of a bombardment of our coast, which is not imposs considering the audacity of the Yankees, and counting, as do, with four or five vessels of higher speed than our own. all these reasons, I am doubtful as to what it would be bes me to do; and I will not take any decision without the opinio the council of captains, as prescribed by the ordinances.

"I leave this letter open until to-morrow, in case somet should happen.

"I have just now been informed that the Vizcaya and Oqu are in sight. I have had the pleasure of seeing them come in of greeting their captains. The crews are in the best of h and spirits, but the Vizcaya needs docking badly. During trip from Puerto Rico she burned 200 tons more than Oquendo, which means a diminution of her speed of from 3 knots according to my reckoning, and a diminution of her sp of action of from 25 to 35 per cent, thus losing the advantag

speed. Both are now coaling, but it is a long job, for, unfortunately, we do not feel at home here. We are indeed unlucky!"

COUNCIL OF WAR OF THE COMMANDERS OF THE FLEET.

It is well known that before the sailing of the squadron the commanders of the vessels held a council of war on board the *Colón*, on April 21.

This is what Cervera wrote:

"The council lasted nearly four hours. The prevailing spirit was of the purest discipline, characterized by the high spirit which animates the whole fleet, and especially the distinguished commanders, who are an honor to Spain and the navy, and whom it is my fortune to have as companions in these critical circumstances. The first and natural desire expressed by all was to go resolutely in quest of the enemy, and to surrender their lives on the altar of the mother country; but the vision of this same mother country abandoned, insulted, and trod upon by the enemy, proud of our defeat—for nothing else can be expected by going to meet them on their own ground with our inferior forces—forced them to see that such sacrifice would not only be useless but harmful, since it would place the mother country in the hands of an insolent and proud enemy, and God only knows what the consequences might be. I could see the struggle in their minds between these conflicting considerations. All of them loathe the idea of not going immediately in search of the enemy, and finishing once and for all. But, as I said before, the specter of the country violated by the enemy rose above all other considerations, and, inspiring themselves with that courage which consists in braving criticism and perhaps the sarcasm and accusations of the ignorant masses, which know nothing about war in general and naval warfare in particular, and which believe that the *Alfonso XIII* or the *Christina* can be pitted against the *Iowa* or *Massachusetts*, they expressly and energetically declared that the interests of the mother country demanded this sacrifice from us.

"One of the captains had certain scruples about expressing his opinion, saying that he would do what the Government of His Majesty should be pleased to order; but as all of us, absolutely all, shared these sentiments—it is hardly necessary to say—his scruples were soon overcome. Another of the captains, certainly not the most enthusiastic, but who may be said to have repre-

sented the average opinion prevailing in the council, has written, by my order, his ideas, which reflect, better than I could express them, the opinions of all. This document exactly expresses the opinion which prevailed in the meeting.

"An act was signed in which it was stated that, having met by order of the commander-in-chief and under his presidency, the second in command and the captains of the vessels, the president submitted to discussion the following point:

"Under the present circumstances of the mother country, it is expedient that this fleet should go at once to America, or should it stay to protect our coasts and the Canaries, and to provide for any contingency?"

"Several opinions were exchanged concerning the probable consequences of our campaign in the West Indies; the great deficiencies of our fleet compared with that of the enemy were made manifest, as well as the very scanty resources which the islands of Cuba and Puerto Rico are able to offer for the purpose of establishing a base of operations. In consideration of this, and the grave consequences for the nation of a defeat of our fleet in Cuba, thus leaving unobstructed the coming of the enemy against the Peninsula and adjacent islands, it was unanimously agreed to call the attention of the government, by means of a telegram, in which the commander-in-chief of the squadron, in agreement with the second in command and the commanders of the vessels, suggested to go to the Canaries. The *Ariete*—it said—boilers in bad condition, those of the *Azor* very old, *Vizcaya* needs docking to paint bottom if speed is to be maintained. Canaries would be protected against a rapid descent of the enemy, and all the forces would be in a position, if necessary, promptly to come to the defense of the mother country."

OPINION OF SEÑOR CONCAS.

The opinion of Captain Victor M. Concas, commander of the battle-ship *Infanta Maria Teresa*, concerning the subjects presented for discussion by the admiral of the fleet at the council of war held on board the *Christóbal Colón*, was as follows:

"(1) That the naval forces of the United States are so immensely superior to our own in number and class of vessels, armor and artillery, and in preparations made—besides the advantage given them by the insurrection in Cuba, the possible one in

Puerto Rico, and the one still existing in the East—that they have sufficient forces to attack us in the West Indies, in the Peninsula and adjacent islands, and in the Philippines. That since no attention has been paid to that archipelago, which was perhaps the most urgent, in order to reduce our vulnerable points, and which could have been done with a single battle-ship, to-day any division of our limited forces and any separation from the European seas involves a strategic mistake which would bring war to the Peninsula, a frightful disaster to our coasts, the payment of large ransoms, and perhaps the loss of some island. As soon as this fleet leaves for the West Indies it is evident—as has happened already more than once (*sic*)—that the American flying squadron will sail for Europe; and even if its purpose was only to make a raid or a demonstration against our coasts, the just alarm of all Spain would cause the enforced return of this fleet, although too late to prevent the enemy from reaping the fruits of its easy victory.

“The only three vessels of war remaining for the defense of the Peninsula, the *Carlos V*, the *Pelayo*, whose repairs are not yet finished, and the *Alfonso XIII*, of very little speed, are not enough for the defense of Spain, and in no way for that of the Canaries. The yacht *Giralda* and the steamers *Germania* and *Normania* are vessels of no fighting qualities and add no strength to our navy.

“(2) The plan of defending the island of Puerto Rico, abandoning Cuba to its fate, is absolutely impossible, because, if the American fleet purposely destroys a city of the last-named island, in spite of all the plans of the government upon the subject, and even if it should be the maddest thing in the world, the government itself would be forced by public opinion to send this fleet against the Americans, under the conditions and at the point the latter might choose.

“(3) Even deciding upon the defense of Puerto Rico alone, the trip across to-day, after the practical declaration of war, without a military port where the fleet might reorganize itself on its arrival, and without an auxiliary fleet to keep the enemy busy—who, I suppose, will make St. Thomas its base of operations—is a strategic error the more deplorable because there have been months and even years of time to accumulate the necessary forces in the West Indies. It seems probable, judging from the infor-

mation acquired, that the supplies accumulated at St. Thomas are intended by the enemy to establish a base of operations in the vicinity of our unprotected Vieques (Vierges). For all these reasons the responsibility of the trip must remain entirely with the government.

"(4) Adding these three battle-ships and the *Cristóbal Colón*, without its big guns, to the two remaining in the Peninsula and to the few and old torpedo-boats which we have left, it is possible to defend our coast from the Guadiana to Cape Creus, including the Balearic and the Canaries, thanks to the distance of the enemy from its base of operations. This defense, however, will have to be a very energetic one if the enemy brings its best ships to bear on us.

"(5) It is very regrettable that there are not enough vessels to cover all points at one time; but duty and true patriotism compel us to clearly express the resources which the country gave us, and the necessities which present circumstances bring on the country in danger.

"(6) Lastly, I believe that the military situation should be made known to the minister of marine, reiterating our profoundest subordination to his orders, and our firm purpose most energetically to carry out the plans of operations he may communicate to these forces. But after pointing out the probable consequences, the responsibility must remain with the government."

FROM CAPE VERDE.

Finally, on April 22, the Admiral said:

"It is impossible for me to give an idea of the surprise and astonishment experienced by all on the receipt of the order to sail. Indeed that surprise is well justified, for nothing can be expected of this expedition except the total destruction of the fleet or its hasty and demoralizing return; when here in Spain it might be the safeguard of the nation.

"You talk about plans, and in spite of all my efforts to have some laid out, as it was wise and prudent, my desires have been disappointed. How can it be said that I have been supplied with everything I asked for? The *Colón* has not yet her big guns, and I asked for the bad ones if there were no others. The 14-cm. ammunition, with the exception of about 300 shots, is ad. The defective guns of the *Vizcaya* and *Oquendo* have not

been changed. The cartridge cases of the Colón can not be recharged. We have not a single Bustamante torpedo. There is no plan or concert, which I so much desired and called for so often. The repairs of the servomotors of the Infanta Maria Teresa and the Vizcaya were only made after they had left Spain. In short, this is already a disaster, and it is to be feared that it will be a more frightful one before long. And perhaps everything could be changed yet! But I suppose it is too late now for anything that is not the ruin and the desolation of our country.

"The Vizcaya can no longer steam, and she is only a boil in the body of the fleet.

"But I insist no more. The act has been done, and I will try to find the best way out of this direful enterprise."

The following are the last letters we know of:

"SAINT VINCENT (CAPE VERDE), *April 24, 1898.*

"I have just received the telegram ordering us to start, and I have given orders to tranship from the Cadiz to these vessels coal, supplies, crews, and the artillery of the destroyers, which was on board the Cadiz.

"I intended to sail without finishing the provisioning of the vessels, but since the Cadiz is to stay, I have decided to ship as much coal as possible. I will try to sail to-morrow.

"As the act has been consummated, I will not insist upon my opinion of it. May God grant that I be mistaken! You see I was right when I said that by the end of April the Pelayo, Carlos V, Vitoria, and Numancia would not be finished; the Colón would not have its big guns, unless we took the bad ones, and we would not have the new 14-cm. ammunition with which to fight, etc.

"With an easy conscience I go to the sacrifice, but I can not understand that decision of the navy* general officers against my opinions.

"I have been informed of the sailing of a cargo of coal for Puerto Rico, where it is supposed to arrive on the 11th or 12th

* In a council of eighteen general officers, fourteen voted for the immediate sailing of Cervera's fleet from Cape Verde. Generals Gomez, Imaz and Lazaga voted against it until the re-enforcement of the fleet by the Pelayo, Carlos V, Alfonso XIII and Lepanto and the three destroyers remaining in the Peninsula. Generals Butler and Mozo shared this opinion conditionally, subordinating it to the decision of the government.

of May, but I am afraid lest it should fall into the hands of the enemy.

"It is a mistake to suppose that I can accept or avoid a naval battle at will. The Vizcaya, on account of her stay in Havar and the nine months without cleaning her bottom, is nothing but a buoy, and I can not abandon her."

ONE TELEGRAM FROM VILLAAMIL.

"AT SEA, May 5, 1898.

"DEAR JUAN: To complete our collection of documents, think you should have the inclosed copy of a private telegram from Villaamil to Sagasta. I send you this letter by means of two destroyers which I am sending to Martinique in search of new All is well on board, and the spirit is excellent. We shall see what God has in store for us. The final result is not doubtful but if only we could start with a good lucky stroke! God be with us! Good-by. Regards to your folk, etc.

"PASCUAL" (Cervera's first name).

[Copy of Telegram.]

PRAXEDES SAGASTA, *Madrid:*

April 22, 1898.

In view of importance to the country of destination of the fleet, I deem it expedient you should know, through a friend who does not fear censure, that, while as seamen we are all ready to die with honor in the fulfillment of duty, I think it undoubted that the sacrifice of these naval forces will be as certain as it will be fruitless and useless for the termination of the war, if the representations repeatedly made by admiral to minister of marine are not taken into consideration.

F. VILLAAMIL

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

COMMENTS OF REAR-ADMIRAL PLÜDDEMANN,
GERMAN NAVY, ON THE MAIN FEATURES
OF THE WAR WITH SPAIN.

[Printed by permission of the Chief Intelligence Officer.]

INTRODUCTORY.

This able analysis of the main features of the Spanish-American war by M. Plüddemann, Rear-Admiral, German navy, presents in a comprehensive form many of the technical deductions of the late war. He comments on the high quality and endurance of our navy ordnance and on the defective results from the navy fuse now in use.

As regards the question of the importance of the Navy controlling the transport service, his reference to the landing of the army at Daiquiri is instructive. Referring to the want of control and discipline on board the merchant steamers chartered as transports for service under the Quartermaster's Department of the Army—that control and discipline at sea which foreign military authorities have long since by experience recognized can only be obtained through the navy—he states:

Under these circumstances it is not strange that the landing of the provisions, guns and ammunition, and the entire equipment, all of which were so much needed in this locality, which offered no resources, was effected with such slowness that the troops were reduced from the outset to the meager rations which each man carried with him.

RICHARDSON CLOVER,
Chief Intelligence Officer.

DECEMBER 21, 1898.

MAIN FEATURES OF THE SPANISH-AMERICAN WAR.

By M. PLÜDDEMANN, Rear-Admiral, German Navy.

(Translated from the *Marine-Rundschau*, November, 1898.)

While the events of the war just ended show nothing which might lead to a radical revolution of present ideas as to rational warfare and the use of modern war material, and while no essentially new appliances have been made use of which might cause us to anticipate a change in the floating material or the weapons of the sea powers, still the war has enriched former experiences. But, on the other hand, it might lead to erroneous conclusions, as many good devices did not have a chance to be tested, the weakness of the adversary making them superfluous, and others not good did not have bad results, because they were counter-balanced by the defects and mistakes on the part of the enemy or by other favorable circumstances.

The following is a discussion of the points which are of special interest to the naval officer:

I. BATTLES OF THE FLEET.

Aside from the moral qualities of the *personnel*, which constitute the prerequisite of success, there are five main factors on which the result of a battle depends—the construction and equipment of the ships, the artillery, the torpedo, the ram, and speed.

The torpedo and the ram have not been used in the late war, for the reason that the hostile ships have never come close enough to each other. It is claimed, it is true, that two Spanish torpedo-boats attempted an attack at Cavite on May 1. But these two vessels were so entirely covered by the rapid-fire artillery of the *Olympia*, even at a distance of 2000 meters, that they could only save their crews by running ashore as fast as possible. It is doubtful whether they were really torpedo-boats. If so, the attack could only have been made owing to entire inexperience with torpedo-boat attacks and complete ignorance of modern rapid-fire guns.

The other two factors, artillery and speed, have proved to be of much more essential and indeed of a very powerful effect. The superiority of the American artillery as to number, caliber, and kind of guns is well known. The general opinion is also that the shooting of the Americans was very good, while that of the

Spanish was miserable. This was the more essential for the Americans at Cavite, owing to the fact that a large number of their shells did not explode. If nevertheless they achieved such a complete success and caused such destructive fires, it was because of the comparatively large number of hits; there were still quite a considerable number of shells that did explode. Even as early as at the bombardment of San Juan it was discovered that many of the shells did not explode; but this fact was most noticeable at the naval battle of Cavite. It is true that at the end of the battle all the Spanish vessels were under water to the upper deck, so that the really mortal injuries could not be verified; the parts above water showed a number of hits, and there is no reason for the assumption that the ratio of exploded shells to that of unexploded ones was essentially different in the lower parts.

The *Reina Christina* showed ten shots that had gone entirely through the vessel; the after smokestack had been torn down by the falling of the mainmast; no explosive effect could be noticed. However, the whole ship had been burned out, which made accurate observation difficult.

The *Castilla* showed considerable explosive effects. The smokestacks and metal bulkheads of the upper deck were pierced in different places by fragments and splinters. The conning bridge and superstructure deck were completely destroyed and torn down.

On the *Don Antonio de Ulloa* the masts were pierced in several places; a 5.7-centimeter shot had gone clear through a 12-centimeter gun shield; the chart house and the starboard side aft showed two hits each, in which there had been failure to explode.

The *Don Juan de Austria* was burned out; effects of firing could not be observed.

On the *Marquis del Duero* the tube of the 12-centimeter starboard gun was bent upward; the cause of this could not be ascertained. Two shots had pierced the ship's side. The upper edge of the smokestack had been indented by a projectile. No splinter effects were noticeable.

On the *General Lezo* the demolition of the smokestack was apparently due to an explosion.

The *Isla de Cuba* showed no injuries.

On the Isla de Luzon the 12-centimeter forward gun, with its whole pivot and shield, had fallen over backward in firing. Two shots (presumably 4-centimeter) had gone through the bow; one of the masts had been grazed by a small-caliber shot. The engine telegraph and superstructures had been demolished; the helm upturned by splinters.

On the Argos nothing could be observed.

The Velasco had the foremast pierced and slightly burned, the mainmast torn down, and the anchor stock shot off.

When the American fleet advanced for the attack it was fired upon by a battery at Manila. The Olympia answered with two shots; both shells were afterwards found unexploded near Luneta. The governor's house at Cavite also showed a shot without explosive effect.

In this respect better results appear to have been achieved at Santiago. This may be gathered from the details known, although the reports refer only in a few instances to the explosive effects attained; but even here a number of cases of nonexplosion have been noticed on the Spanish ships, as well as the fortifications.

The following table gives some data concerning the hits in the naval battle of Santiago:

AMERICAN GUNS.								
	American designation.							
	1-pdr.	6-pdr.	4-in.	5-in.	8-in.	12-in.	13-in.	Total.
Caliber, in centimeters.....	3.7	5.7	10	12.7	20	30	33	...
Number of guns on board.....	22	84	6	12	32	6	8	170
HITS.								
Maria Teresa	1	17	1	4	3	2	..	28
Almirante Oquendo .....	..	46	6	3	7	..	..	62
Vizcaya .....	..	11	4	6	45	..	..	66
Cristobal Colon .....	..	5	..	2	..	..	..	7
Total.....	1	79	11	15	55	2	..	163

This is not quite 1 hit per gun, or, leaving out the 1-pounders, which have only a short range of fire, 9 hits to 8 guns.

The Iowa is the only ship that has 10-centimeter guns, the Brooklyn the only one having 12.7-centimeter guns. These data can not lay claim to absolute accuracy, owing to the extent of the destruction. The calibers of the hits also admit of some margin.

Special mention should be made of the following points: The fallen foremast of the *Maria Teresa* showed 2 hits; 10 hits from 3 ships went into the smokestacks.

On the *Almirante Oquendo* a 20-centimeter shell went through the forward turret roof, exploding, and killing the whole crew in the turret. If the turret had had no roof the shell would have passed over it.

The superstructures on the deck of the *Vizcaya* had been almost completely destroyed by the end of the battle. Whether the torpedo which lay ready for firing in a bow launching tube was detonated by a hostile projectile could not be definitely established. It has also been said that the forward ammunition magazine had exploded.

A 20-centimeter shell hit the protective shield of the second 14-centimeter gun of the *Maria Teresa*, exploded in the rear of it, and killed and mutilated everyone in the vicinity, as did also another shell of the same kind which struck the battery deck aft. Still farther aft two 30-centimeter shells struck so close together that their shot holes were merged into one. Explosive fragments from them had torn a hole 4 feet square in the ship on the opposite side (starboard).

The *Christobal Colon*, although having received but seven shots, gave up the game, seeing that there was no possibility of escape, as even the *Oregon* and *Texas* had caught up with her after a three hour's chase.

In no case has an armor belt been pierced. The greatest destruction comparatively was wrought by the 5.7-centimeter projectiles, while the efficacy of the 3.7-centimeter projectiles was very small, their range not exceeding 2000 meters. They are therefore to be done away with, perhaps a little overhastily, since they were constructed primarily as against torpedo-boats and for use at comparatively short distances.

In connection with the hits, a few figures as to the consumption of ammunition may be of interest, while the total consumption of ammunition is not yet known. Smith, a seaman on board the *Iowa*, fired 135 aimed shots from a 10-centimeter rapid-fire gun in fifty minutes. During the same period of time two 5.7-centimeter guns of the same ship fired 440 shots. The *Oregon* used in all 1,775 shells, but 1,670 of this number were used for the twenty 5.7-centimeter guns alone (or perhaps only for the ten of

one side of the ship), while the four 30-centimeter guns fired 31 shots.

The American material has demonstrated not only its efficacy but also its durability, as only four guns were in need of repairs at the end of the war, in all of which projectiles had burst in bore. This fact, taken in connection with other frequent failure of fuses, shows that the construction of the fuse in America is still far from perfect.

It is well known that the extensive fires on board the Spanish ships were due principally to the fact that the Spanish had not sufficiently considered modern experiences and principles by moving everything combustible from the ships. One circumstance should be mentioned in this connection which has perhaps not been fully appreciated, namely, the danger of wooden decks with pitch in the seams. The danger of these decks was still further increased in the Spanish ships by the circumstance that the planks were not even resting on an iron deck. An iron lining excluding the air and being a conductor of heat naturally decreases the danger of a fire spreading, though it does not obviate it, as the splinters of exploding projectiles pierce the deck thereby causing drafts of air from below. On the *Maria Teresa*, *Almirante Oquendo*, and *Vizcaya* the upper decks and all the woodwork were completely burned, other decks partially.

The Americans had avoided all combustible material in the construction and equipment of their ships; and moreover, special orders were given at the beginning of the war that all the ships should be examined and everything combustible that might have been left or accumulated on board through carelessness should be removed. Besides, the Spanish appear to have relied entirely on their steam pumps and water mains for extinguishing fires. When these had been destroyed or injured by hostile projectiles they had no other means to fall back on. Even the most primitive means for fighting fires, such as fire buckets and tubs filled with water, are indispensable in connection with our modern fire extinguishing equipment which is very effective indeed, but also very complicated.

The thick powder smoke sometimes suffocated the Americans and almost blinded them. They sought to remedy this by tying wet cloths over their heads with small holes cut into them for the eyes. Smokeless powder would probably have had still more troublesome effects.

The range-finders, to which the good-firing results of the Americans were often attributed in the beginning, were not of much use. Owing to their delicate construction, their usefulness was soon impaired. The distances were then estimated from the height of the masts of the hostile ships.

While the Spanish were inferior in every other respect, they might have averted the whole sad catastrophe of Santiago by preserving and taking advantage of their greater speed, which they had shown, at least, at the trial trips of their ships. In this respect the Americans were at a great disadvantage from the outset.

The speed of the two armored cruisers, New York and Brooklyn, was superior by 1 knot to that of the Spanish cruisers, but these were the only ones; the speed of all the other vessels was inferior by from $2\frac{1}{2}$ to 5 miles. The American ships, aside from previous services required of them—the Oregon, for instance, had not reached Key West on her return from San Francisco until May 26—had been blockading Santiago for five weeks. Their boilers were in constant use and could not be properly cleaned; the bottoms of the ships were badly fouled. It is claimed that in order to make 11 knots an hour the ships had to use as much coal as they required to make 16 knots, when in good condition, and even then they could not attain their original speed. The Spanish, on the other hand, had a good opportunity during their six-weeks' stay in Santiago harbor to put their boilers and engines in first-class condition and to clean the bottoms of the ships.

Here, again, the moral qualities of the *personnel* are of the greatest importance. Technical perfection is but an auxiliary in warfare—a *o* which acquires value only by the figure placed before it, namely, the mental qualities of the warrior. It is doubtful, however, whether the Spanish ships ever actually possessed the speed officially claimed for them. At trial trips it is easy enough to use means by which the efficiency attained appears greater on paper than it is in reality, especially if the *personnel* accepting the ship is not of the highest moral and technical standing. In any event, the Spanish engine *personnel* was not equal to its task.

It did not need this war to establish the value of an efficient engine *personnel* for success in war; but the immensity of the catastrophes must make it plain even to the most superficial mind

that it would be very wrong to deny the importance of the vices of the men who give life and motion to the ship by the arduous kind of work simply because they do not handle the anchor and lanyard, but coal shovel and fire hook. The very best human material, strong in body and mind, is the only kind suitable for this work, and a navy should spare neither trouble nor expense to secure it.

On the subject of the efficiency of monitors opinions in United States naval circles were much divided at the beginning of the war. The North Americans are the only ones who still continue to build this type of ship. Little has been heard of their services during the war. Two of them went from San Francisco to the Philippines, the greater part of the way in tow of the colliers. The Monterey, accompanied by the collier Brutus, left San Diego, Cal., on June 11 and arrived at Manila on August 16. The distance is 7600 miles, 3725 miles of which she was towed. Twice she had to touch at anchoring places, namely, at Haiphong and Guam. She was towed from the 8th to the 23d of July, 712 miles; from the 5th to the 22d of July, 2541 miles, and from the 25th to the 28th of July, 472 miles; average speed while towed, 6.76 knots. The weather was fine during the whole trip with the exception of a slight storm on July 31. The voyage took in all two months less seven days. The Monadnock followed exactly the same length of time, having left San Francisco on June 23 and arrived at Manila on August 16.

These voyages are quite remarkable as far as sea efficiency is concerned, but when it comes to war efficiency they had better not be relied upon. The confidence in the efficiency of the monitor for war purposes has been considerably shaken. Cap. Mahan, who used to argue in favor of a defensive navy composed of monitors, has recently expressed the opinion that the inefficiency of the monitors had now been proved; that they had become a constant impediment to the fleet owing to their lack of space, limited coal capacity, and unstable platforms, which completely excluded effective firing in a bombardment. For harbor defense also he prefers land fortifications to monitors.

II. BOMBARDMENTS.

What might be the results of a serious battle between armored ships and coast forts the war has not demonstrated. The An-

cans in these instances have never gone close enough to make it possible to note decisive results on either side of the belligerents. They should not be blamed for this. If they could obtain their object without taking greater risks, it would have been a mistake to take such risks, and they certainly did attain their object. The great injuries, however, which the Americans claimed to have inflicted at different times have subsequently proved to be exaggerations and delusions. Even at target practice we believe only reluctantly the statements of "too short" or "too far" made by an observer favorably stationed. The claims that the forts had been silenced, which would presuppose that the guns had been dismounted, were also founded on delusion.

There is no doubt that the Americans had better guns than the Spanish in their land batteries and could fire at distances which the Spanish guns could not reach. When this was recognized ashore and the firing stopped, the ships thought they had silenced the batteries. It has therefore been demonstrated that the ships were unable to seriously injure the land fortifications at great distances. After all the bombardments of Santiago there was but one gun dismounted in each of the batteries at the Morro and the Socapa. It has not been demonstrated whether with equal armaments and skill in firing on the part of the Spanish the ships would not have seriously suffered. Still less has it been demonstrated what the relative situation of the belligerent parties would have been if shorter distances had been chosen.

The employment of torpedo-boats for bombardments, as at Cardenas, must be designated as entirely unsuitable. Torpedo-boats are expensive and delicate vessels, equipped for launching torpedoes and for great speed. Their guns are intended to be used only in extreme cases. When the torpedo weapons can not be used their other principal quality, speed, in connection with the circumstance that they draw little water, may be utilized for the transmission of orders and information; but bombardments, even in narrow and shallow waters, had better be left to the most primitive gunboats, etc.; they can do better work and are less expensive, but can never take the place of a disabled torpedo-boat.

The so-called dynamite cruiser, *Vesuvius*, was a failure. Her projectiles can be fired only at medium and short distances, and cannot be aimed. The terrible effects claimed for hits can not

be considered as counterbalancing this. It is true that an accidental hit may cause great havoc, but in this age of accurate firearms we should no longer reckon with such uncertain factors. The Americans have utilized the vessel accordingly. They used to send her at night against the coast defenses, counting on accidental hits, while the vessel, protected by the darkness, did not betray her presence by any flash at the discharge nor by smoke or detonation. Nothing has been heard of any particular result. No attempt was made to carry out the idea, so much talked of at first, of destroying the mine obstructions by systematic bombardments of the harbor entrance. In order to do this it would have been necessary for the vessel to approach the shore in daytime, when she would have been exposed to the very dangerous fire of the coast forts, and a systematic bombardment could hardly be spoken of in view of the uncertainty of a fire.

The Americans consider this vessel a failure, as also the ram *Katahdin*, which, aside from four rapid-fire guns, has no other weapons but her ram.

III. COAST DEFENSE.

Some obstructions by means of vessels and mines were laid out by both belligerents, but have not come into play. The Spanish had attempted to close the entrance of San Juan Harbor in Porto Rico and that of the Pasig River at Manila by sunken vessels. In the latter case it was the opinion of German officers that it did not constitute a military obstruction, although it interfered considerably with the movements of shipping.

The two mines which were blown up in front of the *Olympia* at the beginning of the battle of Cavite were not intended as a regular obstruction of the channel, but represented only a small mine field for vessels that might accidentally pass over them. They were fired prematurely.

In the entrance of Guantanamo Bay the Americans found quite a number of mines. These might have caused considerable damage if they had operated, for the Americans entered the bay without any precautionary measures, and the screws of the *Marblehead* tore two of the mines loose from their anchorages so that they rose to the surface of the water. Then the whole bay was systematically searched for mines. This was done on June 21 by the boats of the *Marblehead* and *Newark*. Four steam

launches, under the fire of Spanish infantry hiding on the shore, fished up thirteen mines on the first day with light chains they were towing. The ships, of course, fired on the hostile position, which was soon abandoned. During the next few days thirty-five more mines were found and taken ashore. These proved to be charged with 120 pounds of gun-cotton each. Many of them showed evidences of having been in contact with ships' bottoms or screws, but the firing mechanism was not capable of operating. The fuses showed such grave defects that it was quite evident that the work of constructing them had not been done under the supervision of a superior.

The mines raised in Santiago Harbor after the surrender of the place proved on the whole to be in better condition. Still, the outer row containing contact mines was of doubtful value. One mine was found, for instance, in which half of the gun-cotton had been burned, leaving no doubt that it had been in contact with some object—probably the Merrimac—and that the fuse had acted, but that the gun-cotton charge had become spoiled.

The second row of mines (electric) was in pretty good condition and might easily have destroyed one or more ships if an attempt had been made to force the entrance. These latter mines contained a charge of 200 pounds of gun-cotton each. All the mines in Guantanamo as well as Santiago Bay were thickly overgrown with barnacles and seaweeds.

As a curiosity, it may be mentioned that lightning struck an American mine in the lower Mississippi and exploded it, and that several mines in the Potomac were exploded by lightning at a few seconds' interval without causing any disturbance in the rest of the mine system. They blew up exactly as it was intended that they should be blown up in war.

IV. BLOCKADES AND CRUISER WARFARE.

Both of these were applied by the belligerents in the mildest possible form. Spain can hardly be considered in this connection. She could do no blockading, and it is somewhat doubtful whether it was quite voluntarily that she abstained from capturing hostile merchantmen. The Americans were enabled to maintain quite an effective blockade on the coasts, which they designated as blockaded, by means of the large number of yachts and other steamers which they had incorporated into their navy as

auxiliary vessels, while their large ships were giving their attention to the hostile naval forces.

It can hardly be said that the Americans carried on systematically any destructive warfare as against Spanish merchantmen. Those they did capture almost ran into their hands, so to speak. This was especially the case at the beginning of the war, mostly with vessels which, owing to the usual Spanish carelessness, had received no warning of the fact that hostilities were about to break out. This was even the case with the Spanish gunboat Callao in the Philippines. Still a few prizes may be mentioned which were captured while making a direct attempt to run the blockade, also a few cases where vessels were chased till they ran ashore, while a few fast Spanish vessels succeeded in running the blockade. But neither the successful nor the unsuccessful attempts at running the blockade were of much importance.

A number of neutral vessels were also captured, but nearly all of them were released again, for the American Government, in adjudicating their cases, showed a liberality which was quite unheard of in former naval wars and which probably had a political background. About thirty vessels in all were considered good prizes.

As the United States as well as Spain have refrained from privateering, although they were the very countries which reserved that right at the time of the Paris declaration, it may be assumed that privateering is definitely at an end.

During the blockade of Santiago the harbor entrance was at night kept constantly under the light of the projector of some ship designated for the duty and boats were stationed at intervals between the other vessels and the shore, so that any attempt of the Spanish ships to go out might at once be perceived. It has been commented upon that the ship so illuminating the harbor entrance was hardly ever fired upon by the fortification works. It would seem as though telegraphically connected observation stations at the Morro and Socapa could have ascertained the exact distance of the troublesome watcher and made her work, if not entirely impossible, yet extremely difficult by firing upon her.

V. LANDINGS.

The landing of the Americans at Daiquiri is the largest landing effected since that of the western powers at Balaklava in the

Crimean war. Yet the total forces landed did not exceed 15,000 men, embarked in fifty-three steamers. It took a long time before the troops were ready to start, for everything required for an army and a landing had first to be procured. When the expedition finally did start it was found that a great deal had been overlooked or was incomplete, or had been lost in the chaos, or could not be secured. For instance, no cavalry horses—except for one troop—could be taken along because there had not been time to fit out the vessels for the reception of horses. The voyage and the landing were effected in the most beautiful weather; the Americans had good luck, as they always did. The forces were landed unmolested.

The disembarkation was effected almost entirely at a small landing bridge where but two boats could go alongside at a time. Attempts to have boats run ashore on the small sandy beach, at one end of which was the bridge, had to be abandoned after the loss of several boats, which were wrecked in the surf on the projecting rocks and stones. The report that the United States warships had first fired on the open strip of land back of the landing place and routed the Spanish should not be taken literally. No such open strip of land exists there. The rocks reach close to the sea, offering hundreds of sheltered places from which the bridge might have been fired upon. Authorities in military matters state that 300 men, though they might not have been able to prevent the landing entirely, could have caused great losses. But on this occasion, as on so many others, the Spanish showed that they had no appreciation of military situations, and as soon as the bombardment commenced they retreated. They need not have paid much attention to the Cubans. The Spanish ought to have known that now that the Americans had arrived the Cubans would avoid danger even more than before.

With the landing of the army all operations on the part of the Americans ceased for a while. In spite of the most exhaustive use of all the boats and auxiliaries of the warships, including the armor-clads guarding the entrance to Santiago Harbor, it took several days before the field guns and luggage could be brought ashore, to say nothing of the siege guns. It was found that there ought to have been many more lighters, especially such as are equipped with lifting apparatus. There was only one of these—a second one had disappeared during the voyage. There were no

devices for landing horses and mules which were intended for drawing the guns. The animals were hoisted overboard, and it was taken for granted that they would swim ashore. But in a number of instances this did not happen. Many of the frightened and bewildered animals swam out to sea and were drowned. As all the boats were being used in the landing and were crowding each other for hours at the landing place, there was none available to go after the mules and lead them in the right direction. The few men in charge of landing the animals had all they could do to get those that swam ashore out of the surf and in safety. About 50 animals perished.

There was lack of management generally. No one in authority had been appointed commander of the landing place. The commander-in-chief, General Shafter, did not trouble himself about the landing. Admiral Sampson had only made arrangements as far as the warships and their boats were concerned. The only landing bridge was but partly covered with loose boards. No material nor tools were at hand to build other bridges, and little attention was given to the one bridge in existence, as is evidenced by the fact that three weeks later the loose boards were still loose.

The conditions at Siboney, where part of the troops and supplies were landed a little later, were quite similar, except that there was no bridge at all. But in calm weather a few boats could be run ashore side by side. No bridge was built here for the landing of the voluminous luggage.

The relations between the military authorities and the officers of the transport steamers had not been regulated. The latter had only their own advantage and that of the ships' owners in view, and did not pay the least attention to the wishes and plans of the officers of the troops. The greater part of the time they kept at a distance of from 3 to 20 miles from the shore, to make sure not to go too near or to get into collision with other vessels, and if at times they did assist in unloading their cargoes, they would return to the sea as fast as possible as soon as fire was opened ashore, often taking with them the most indispensable articles of the army equipment. An American reporter even calls them insolent, un-American, mutinous cowards. The army authorities were unprepared and powerless before such conduct on the part of the officers of the transports. Under these cir-

cumstances it is not strange that the landing of the provisions, guns, and ammunition, and the entire equipment, all of which were so much needed in this locality, which offered no resources, was effected with such slowness that the troops were reduced from the outset to the meager rations which each man carried with him, and where these had been thrown away, as had been done in many instances in order to lighten the weight, the soldiers suffered hunger.

VI. COALING.

The late war will give a new impulse to the important question of supplying coal. Ships and fleets carrying on war in a region where they do not have available bases of supplies and coal depots in their immediate vicinity, or whenever they are not certain that there may not be occasion for their having to leave such region temporarily, should have their own colliers along. The colliers should have the same speed as the squadron. The ships should not be compelled to rely on rendezvous or the uncertainty of colliers sent after them. But not only should care be taken to have a sufficient supply of coal, but also to provide appliances for taking coal on board under all circumstances in the shortest possible time. The lack of such appliances has contributed not a little to the disasters of the Spanish. The coaling of Admiral Camara's ships at Port Said was nothing but a comedy. Admiral Cervera intended to coal rapidly at Santiago and proceed. But the appliances for that purpose proved so defective that the United States fleet had shut him up in the harbor before he could finish coaling, which operation took several days. At present not many ships are being built with that end in view, nor are they being equipped with appliances for coaling in the shortest possible time. This will be absolutely necessary in future, so that the ships may be enabled to take on coal or other fuel either from a wharf or from a lighter or collier at sea.

VII. AUXILIARY WARSHIPS.

What can be done with money and a practical mind in the matter of securing naval war material the Americans have done since the war cloud first appeared on the horizon. It is true that the purchase of foreign warships before the beginning of the war proved almost a failure. The United States bought the fol-

lowing Brazilian warships: The protected cruiser Amazonas, of 3,450 tons, afterwards called the New Orleans; the protected cruiser Almirante Abreu, same size, afterwards called the Albany, and the cruiser Nictheroy, of 7,080 tons, afterwards called the Buffalo, which, aside from her good rapid-fire armament, had a 38-centimeter dynamite gun; from other sources, the cruiser Diogenes, of 1,800 tons, renamed the Popeka, and a torpedo-boat purchased in Germany, called the Somers. The only ones of these that were assigned to the active fleet were the Topeka and the New Orleans. The Albany and the torpedo-boat Somers, which were still in England after the breaking out of the war, were not allowed to leave there on account of England's neutrality. The Buffalo did not leave the navy-yard during the war. The United States had better luck with the merchant steamers they purchased and converted into auxiliary cruisers and gunboats.

They bought 60 yachts and other steamers as auxiliary gunboats and scouts, 4 large fast ocean steamers as auxiliary cruisers, 11 tugs, subsequently armed. The following were chartered: Four large ocean steamers as auxiliary cruisers. Placed in commission: Fourteen revenue cutters as auxiliary gunboats and scouts. In all, 93 steamers for warlike actions, more or less armed and fitted out for that purpose.

There were also purchased as adjuncts of the fleet 20 transport vessels, 9 colliers, 1 repair ship, 2 water-distilling ships, 2 ice-manufacturing ships, 3 hospital ships; in all, 37. This does not include the temporarily chartered steamers for the larger troop transports.

The large auxiliary cruisers were also occasionally utilized for the rapid transportation of troops. The auxiliary gunboats were indispensable for the blockade of the extensive stretch of the coast. The names of several of these, even of tugs, have been specially mentioned in several of the battles. A few of the auxiliary vessels, as, for instance, the St. Louis and the Zafiro, were equipped with special devices for dragging for cables, which they have used with good success.

As for the adjuncts of the fleet, the distilling ships were intended especially to furnish fresh water to the blockading auxiliary vessels and the transports of the landing army. As most of these vessels had inadequate distilling apparatus, some of them

none at all, this was necessary, so that they might not be compelled to leave the blockade for the purpose of renewing their water supply. The repair ship *Vulcan* was also equipped with a powerful distilling apparatus.

The ice-manufacturing ships supplied the vessels not equipped with ice machines, also the hospitals of the invading army of Cuba. The object of the other adjuncts of the fleet is self-evident.

The repair ship *Vulcan* has proved extremely useful, even indispensable for the blockading fleet at Santiago. She supplied 31 vessels with extra engine parts, material, and tools. Twenty-six vessels were repaired, and a number of repairs were also made on guns and their equipments. The *Vulcan* also rendered important services in connection with the raising of the *Maria Teresa* and is now doing the greater part of the work in temporarily repairing said ship for the purpose of transferring her to one of the United States navy-yards.

How important it is to own transports specially fitted out for the transportation of troops and war material has been demonstrated in this war, though principally by the lack of vessels equipped for such service. Of the transports purchased during the war, the Navy Department intends to retain 16, which are to be refitted for service as regular marine transports, namely, the *Panama*, *Port Victor*, *Rita*, *Mohawk*, *Mobile*, *Massachusetts*, *Manitoba*, *Minnewaska*, *Mississippi*, *Michigan*, *Roumania*, *Obdam*, *Berlin*, *Chester*, and *Britannia*, employed on the Atlantic ocean, and one on the Pacific coast. During the war they were used not only for the transportation of troops, but also for supplying provisions and material.

It would have been very desirable to have had even more of these. The blockading fleet, for instance, complained of the very defective mail service, as also of the fact that, although it was comparatively but a short distance to the United States ports, so few fresh provisions were received, which circumstance impaired the health of the troops.

Vessels built for special purposes are in times of peace, at maneuvers, stepchildren of the Navy; they are considered expensive and troublesome adjuncts which have to be taken into consideration in maneuvers and impede their rapid execution; and yet how useful they are and how much relief they are able to furnish in

actual war! Whenever mobilizations show that there is a sufficient number of suitable merchant steamers which would unquestionably be at the disposal of the Navy at the beginning of war, provision should be made to have vessels set apart which can be easily equipped for such purposes, and, if necessary, to own and keep in constant readiness a number of such special vessels even in time of peace.

The next number of the Institute Proceedings, issued the last of March, will contain the following articles :

THE ST. LOUIS AS AN ARMY TRANSPORT.

By her Commanding Officer, Captain C. F. Goodrich, U. S. Navy.

THE LAST NAVAL ENGAGEMENT OF THE WAR.

By Lieutenant W. F. Halsey, U. S. Navy.

THE COAST SIGNAL SERVICE.

By Lieutenant F. B. Anderson, New York Naval Militia, who was on the Board to organize the Service.

SOME EXPERIENCES ON A TUG BOAT DURING THE WAR.

By Ensign W. S. Crosley, U. S. Navy.

SEAVEY'S ISLAND PRISON AND ITS ESTABLISHMENT.

By Paymaster J. P. Loomis, U. S. Navy, who was the moving spirit in establishing and maintaining the prison from the Commissary's standpoint.

THE HYGIENE OF THE NAVY RATION.

By Surgeon H. G. Beyer, U. S. Navy.

RANGE OR DIRECTION INDICATOR.

By Lieutenant Armistead Rust, U. S. Navy.

Beginning with the next number the binding of the Institute Proceedings will be changed to a more attractive form.

Throughout the year articles and discussions on the war will appear, and it is the intention to get the best papers.

It is the desire of the Board of Control to increase the interest of the Service and the public in the Institute and its work.

To this end the aid of the members and friends is solicited.

1. The first part of the document is a list of names and titles, including "The Hon. Mr. Justice" and "The Hon. Mr. Justice".

PROFESSIONAL NOTES.

RUSSIAN VIEWS OF OUR WAR.

Admiral MAKAROFF's Views of the Lessons of Santiago.

**RELY ON YOUR GUNS—NEVER SACRIFICE ARTILLERY TO ARMOR—THE
SWORD ALWAYS MIGHTIER THAN THE SHIELD—A VICTORY EXACTS
THE SAME CONDITIONS ON LAND AND SEA.**

(From the St. Petersburg Kottline.)

The destruction of Cervera's ships at Santiago has again brought to the front the question, Should the principal force of a fleet consist in armored or unarmored vessels? If under the name of cruisers are classed vessels of light artillery intended to prey upon the commerce of the enemy, the only possible answer is that armored vessels are preferable to cruisers. An enemy never considers himself beaten because his commercial fleet is captured. For each ton of armor from four to five tons displacement will be necessary. Consequently a ship carrying an armor of 2000 tons would require a displacement of 600 or 800 tons more than that of an unarmored cruiser having the same speed and radius of action. Consequently, battleships must always be large, while the dimensions of unarmored cruisers may vary all the way down to those of torpedo boats. There is no advantage in making unarmored vessels very large, because it is, of course, impossible to utilize all their displacement for their artillery. They must have powerful machines and must carry an enormous supply of coal. It would not be difficult to construct an unarmored vessel of 3000 tons, carrying one gun of 25 centimetres and five guns of 15 centimetres, and having a speed of twenty-one or twenty-two knots, with the machinery, the boilers and the magazines sufficiently protected. But, if we are asked which is the more powerful as a unit in combat, a battleship of 15,000 tons or an unarmored vessel of 3000 tons, the reply, of course, must be in favor of the armored ship. If, on the other hand, the question is whether it is more advantageous, for a determined sum, to build one warship of 15,000 tons or four armored vessels of 3000 tons, the answer can no longer be in favor of the battle-ship.

All the writers who have dealt with this question, with the exception of Lieut. Engleman, have pronounced for the battle-ship.

Now, let us look at the lessons that we can derive from the battle of Santiago. We find there that the two adversaries were supplied with armor and modern guns of both heavy and light calibre. In reality there is not a line of demarcation well traced out between the cruiser and the battle-ship. The Iowa and the other Armerican ships are called battle-ships, but they possess only a limited supply of armor plates, the thickness of which at the water-line is 355 millimetres, and a surface protection of 186 feet. Three of the Spanish cruisers, the Infanta Maria Teresa

and two others of the same type, had armor of 305 millimetres in thickness at the water-line and 315 feet of surface, but of less width than that of the American ships. Upon these cruisers the barbettes, armed with cannon of 21 centimetres, were protected by a *cuirasse* of 255 millimetres. The Iowa, with a displacement of 4500 tons more than the Spanish cruisers, also had her guns protected, but by an armor of only 100 to 200 millimetres, an utterly insufficient protection against the projectiles of cannon of 28 centimetres.

The cruiser Cristobal Colon had an armor of the recent type, protecting nearly three-fourths of her surface and sheltering even her small guns. Her displacement, it is true, was only 7000 tons, utilized for the most part by her armor; that is to say, the artillery was sacrificed for the sake of the armor. Nevertheless, the Cristobal Colon had two Armstrong guns of 25 centimetres and forty calibres in length and of the most recent type. Her projectiles should have pierced the armor of the American vessels in ordinary conditions of combat.

Each one of the two parties engaged, therefore, was provided with armor, and with guns sufficiently powerful to pierce it. The extent of the unprotected surfaces was greater on the American side. The Americans had a numerical superiority. Nevertheless, the victory might have gone to the other side or, at all events, have been dearly bought by the victor. If, in the battle of Santiago, the Spanish projectiles did not strike the American fleet, it is not to the armor that the latter should attribute its victory, but to the accuracy of its fire, and the quality and order of its shots.

We do not know if the Spanish ships practiced firing much in time of peace, but after all, that sort of practice is nothing compared to what had in actual warfare. The journals which every day gave us accounts of the bombardment of Spanish forts by Admiral Sampson and Commodore Schley were silent upon the operations of the artillery of Admiral Cervera.

From a moral point of view the two fleets were diametrically opposed. The Americans were seeking a combat and had entire confidence in the artillery. The Spaniards, under the pressure of orders from Madrid, came out of Santiago with the absolute certainty of meeting the disaster that awaited them. In this passive rôle they could only count upon the armor and their speed. The speed did not come up to the power of the machines on account of the poor quality of the coal and the growth that covered the immersed portions of the vessels, and, perhaps, also to the inexperience of the machinists. There remained, therefore, only the armor, which inspires so much confidence in the minds of so many people and is supposed to protect a vessel, leaving out all other elements, material or moral. There was no reason why that protection should not exist in the battle of Santiago; nevertheless it was not sufficient for the Spanish fleet.

At Lissa the armor did not prevent the *Re d'Italia* from sinking, nor the *Palestro* from blowing up. At the battle of Yalu it did not save the Chinese fleet; neither did it prevent the Chinese cruisers from being sunk by the Japanese torpedo-boats at Wei Hai Wei.

We are, therefore, brought to the conclusion that in a naval battle it is better to rely upon the strength of the weapon rather than upon the solidity of the shield. Put more artillery and torpedoes on board your battle-ships, arm them with solid rams (*éperons*) and reject the idea of pro-

tecting them with armor, because that does not assure the victory; it only retards the defeat. Such a small result does not warrant the construction of vessels overloaded with armor.

(*From the Invalide Russe.*)

In our opinion Admiral Makaroff clearly explains the fundamental cause of the Spanish disasters on sea and presents sound views of what should be expected from modern fleets. It never enters into the minds of land-men when dealing with a military engagement to seek the causes of defeat in the thickness or the height of the earthworks of one or the other of the two adversaries. We know that the decisive attack is prepared by an intense and accurate infantry and artillery fire, and that the exigencies of victory require a thorough preparation for a hand-to-hand fight. Although the armor of warships, sheltering their vital parts, is of far more importance than the intrenchments of land forces, a naval combat exacts the same material means of attack and the same moral qualities as a land battle. On land the preparation depends especially upon the infantry fire; on sea, of course, the artillery plays the principal part, and the intensity of the shock is measured by the distance between the fighting vessels.

Consequently a powerful artillery with trained gunners is the principal essential, to which must be added sufficient speed to approach the enemy or avoid the combat. Of course there should be a reasonable protection against the projectiles of the enemy. To present these conditions in another order, that is to say, to sacrifice the artillery or the speed to the *cuirasse*, is simply to disarm and invite destruction. Armor rarely saved a fleet, and it never gave one a victory. The last naval wars have proved this conclusively. The victory belongs to the attacking party on sea as on land.—*New York Sun*.

LESSONS FROM THE BATTLE OF SANTIAGO.

Since we discussed the information received as to the facts of the destruction of the Spanish cruisers by the American fleet, fuller accounts have come to hand. We may especially mention the official diagrams of hits made on the Spanish vessels, given in the *Scientific American* of September 10th, and the accounts of two correspondents who were eye-witnesses of the fight, one from the deck of the Brooklyn and the other from that of the New York, published in *McClure's Magazine* for September. These we do not propose to review in any sense, although we are making use of information obtained from them in forming the conclusions which we think are to be drawn from the character and occurrences of the fight.

First, a few words as to the actual conditions of action. The correspondent on board the Brooklyn was probably exactly in the best position to see and report the progress of the engagement. We may remind our readers that the Spanish ships steamed out of the harbor towards the west in succession, passing the west end of a line of United States men-of-war blockading the harbor. The Brooklyn, lying at the west end, was thus best placed to pursue the Spanish ships, both because she had some start as to her position, and also because she had the highest speed of any ship in both fleets. Mr. Graham's account is spirited and graphic,

though here and there rather too florid for professional readers. No naval officer, for example, would accept the statement that "the situation for the Brooklyn now seemed desperate," because the Spanish cruisers were running towards her. She had the overpowering strength of the United States fleet with her. She had, no doubt, to avoid exposing herself to being rammed, which she apparently very easily did by turning her head to starboard, so as to trade round with her stern towards them. She fired her broadside from her port guns, but she necessarily lost ground in going to meet the Spanish ships, who must have gained on her as she moved. Certainly the United States fleet got under weigh with admirable promptness, but we must pass on to our discussion of the effect of the fire as a whole, and the lessons to be drawn from it. The curious fact is to be noticed in passing that the Spanish ships, whose object was to escape, and who would certainly have benefited by smoke to conceal them, used smokeless powder; while the United States ships, who were endeavoring to pour in as accurate and rapid a fire as possible, were much hindered by the fact that they had not smokeless powder. No doubt the evil was modified by the speed at which the ships were running, and it appears that officers were sent aloft on board the Brooklyn to tell the gunners the effect of their shooting. Probably the smoke would scarcely reach this height before it was left behind. Yet the directions seem to have been of a very general character, and the statement that "every shot is telling," while encouraging, was only correct if it referred to every shot that hit, for the large number that we know missed could hardly tell even morally on an enemy that was running from the Brooklyn; most properly so running, for it is absolute nonsense to talk as if the Spanish cruisers could do otherwise. When truth forbids us from crediting them with anything else, we must allow that the Spanish made a gallant attempt to get their ships out, and gave their lives lavishly to effect it.

To get an idea of the circumstances of the firing, we cannot do better than follow the account of Mr. Graham, on board the Brooklyn. Apparently the enemy next appeared as a dark mass through the smoke, and after coming round, the Brooklyn attacked first the *Maria Teresa* and then the *Vizcaya*—generally from about a mile and a quarter to a mile and three-quarters range—till she turned in and ran ashore, and lastly the Brooklyn gave chase to the *Colon*, who had managed to show speed enough to have gained a lead of over three miles. The Brooklyn was only able to make 17 knots, because she had been unable to couple her forward engines, so that the *Colon*, who had the advantage of getting up her steam deliberately, ought to have escaped, had she been in fair order. To come, however, to the gunnery of the Spanish ships, the *Maria Teresa* and *Oquendo*, with no heavy guns, and only ordinary 5.5-inch guns never had a chance of successfully running the gauntlet of the heavy battle-ships *Texas*, *Iowa*, and *Indiana*, which fired on them, though they had not the speed required to follow the cruisers far. The *Oregon*, indeed, was able to keep up well throughout. The *Vizcaya* for a time has mainly the Brooklyn to deal with her. Mr. Graham writes as if the *Vizcaya* ought to have been more than a match for the Brooklyn. She certainly had thicker armor, especially at her belt, but this could not prevent her other parts being destroyed by the greater fire of the latter. Had all the guns been complete, the Brooklyn's entire energy of fire per minute is about 192,032 foot-tons, against 179,203 of the *Vizcaya*. Probably the Brooklyn could bring to bear three of her four 8-inch, and

half of her twelve quick-fire 5-inch guns, giving an energy of 111,012 foot-tons per minute, against 107,625 foot-tons delivered by the Vizcaya's two 11-inch guns, and half of her ten quick-fire 5.5-inch guns. We fear, however, that the Vizcaya's heavy guns were non-existing, so she had only 71,580 foot-tons energy of fire, and, as a matter of fact, seems to have been able to deliver very little effective fire at all, partly from bad gunnery, and partly, perhaps, owing to injuries received in passing the slow battle-ships. Under these conditions the Brooklyn would be able to man all her light unprotected quick-fire guns, which we have not taken into account hitherto because men could hardly live at them in close action. Consequently the Vizcaya would be subject to all the Brooklyn could do, and in about twelve minutes the Oregon joined in and destruction rapidly followed, so that in six minutes she ran ashore hopelessly on fire. She had received five 8-inch, seven 5-inch, four 4-inch, and thirteen 6-pounder shells in all. The story of the Vizcaya is more or less that of all the Spanish cruisers, except the Colon, whose 6-inch plate protection to her upper structure and general condition put her in a very different position, and ought to have secured her escape had her speed been kept up. Their vital parts were protected by their belts, but they were destroyed by fire and wholesale cutting to pieces of their secondary parts and crews. This was effected mainly by the quick-fire guns, but few heavy gun projectiles going home, the above-mentioned 8-inch shells being the best performance. Apparently, the most important elements for success in a running fight, such as took place, are, first, speed; secondly, gun power; thirdly, power of resisting conflagration. The first requires little comment. It is a question of actual speed obtained in trial and of keeping the engines and bottoms of the ships in order. It is well to note that the notorious Huascar was eventually caught up and disabled only by cleaning the bottom of the Cochrane, and securing the slight superiority in speed that enabled the Blanco and Cochrane to over-haul the Huascar. We might indeed alter the old proverb, "For want of a nail the shoe was lost, for want of a shoe the horse was lost, and so the rider and kingdom," to read, for want of a cleaning the three knots were lost, for want of three knots the cruisers were lost. On the other hand, in virtue of a clean bottom some years ago Captain Kane was just able to withstand the wind that drove other ships on shore, and get his vessel safe out of Samoa Harbor. On the importance of our first point, then, namely, good engines and clean bottoms, we must all be fully convinced.

The second point is efficient fire. This seems to be best delivered in the form of heavy quick fire; that is, the fire of quick-fire guns mounted behind medium armor. This we have long insisted on. Leaving the question of conflagration till the last, so far as gun-fire was concerned, the Spanish gunners might have stood to their guns had they been in 6-inch casemates, for the American 5-inch quick-fire guns could not by any possibility have perforated them. As to the question of accurate shooting, whatever was the exact proportion of rounds that took effect, it is clear that the American officers found that they had considerable opportunity of testing their powers of shooting and improving it, in spite of some casualties, as they went on. We read, for example, of George Ellis deliberately measuring and recording the range in an exposed position, and his head being instantly afterwards carried away by a shot. The measure of success attained may have fallen short of what

we should hope from results of practice-firing; but however this may be, it is quite clear that accurate shooting was very desirable, and that the relative positions of any two ships engaged depended greatly on it.

Lastly, as to the incendiary action of the shell, this is a newer and more important point. Constructed as the Spanish cruisers were, primary attack of vitals was very difficult, and was not attained at all, we think. Secondary attack by quick-fire common shells practically settled the matter. How far is this of general application? Had the Spanish ships been built like the Germans, without wood anywhere, they could not have been set on fire. Are not the Germans right, and ought we to follow the same line? We specially have no doubt to keep in view the inhabitable character of our ships; but does not this action show us that wood must at all costs be given up? It seems strange that wood should burn as it does. We might explode loose powder on the floor of a room without setting it on fire. The fact is that a bursting shell drives large lumps of burning explosive into the wood, and once there, water would probably fail to extinguish it, seeing that it has its own oxygen incorporated in it in a solid form, and would burn freely under water. It seems hardly possible for a ship containing much wood to escape fire, especially under quick-fire attack, for a 6-inch or 5-inch shell would set a vessel on fire nearly as well as a larger projectile. Are we then to depend on quick-fire? We think not altogether, for we can conceive the case of two ships blowing each other's secondary parts to pieces to a great extent and yet remaining intact as to their vital or primary parts. Once this action is pushed far, it is clear that the vessel which perforates the other's thick armor best is likely to carry the day. Naturally, however, different classes of ships have their special functions. It is interesting to turn to existing types to see how they would have acquitted themselves at Santiago. The *Esmeralda* would, we think, have found the very work she is suited for. Her very high speed would have carried her rapidly away and her tremendous fire would have made her very ugly to approach. On the other hand, we have repeatedly condemned the light pieces carried by the *New York*. It is curious that she should just have missed the opportunity of showing her powers.—*The Engineer*.

THE LIFE OF NAVAL ORDNANCE.

WASHINGTON, November 7, 1898.—The Navy Department has received reports from nearly all the war vessels which took active part either in the battles or the bombardments of the Spanish-American war. These reports show in detail the number of rounds fired from every gun on board from 1-pound rapid-fires up to the big 13-inch rifles, and the Ordnance Bureau experts have examined them with much interest to note the condition of the guns before and after firing in order to estimate the probable deterioration resulting from the war service. The department officials are disposed to treat the figures of the reports as confidential military information not to be made public, but Captain O'Neil, chief of the Ordnance Bureau, and Professor Alger, ordnance expert and mathematician, have given the correspondent of *The Iron Age* some interesting information concerning the condition of the guns and the severity of the tests to which they were put during the war. In this connection Captain O'Neil said:

"Our reports show that our ordnance, from the smallest guns to the largest calibres, developed the highest degree of efficiency and little if any deterioration. I speak especially of the large calibre guns when I say that no evidence whatever has been found that the ordnance has developed any weakness. So far as I am advised not a single gun has shown any bad effects from the firing tests to which so many of them were subjected, and there has not been even a suggestion of drooping muzzles or other evidences of structural weakness. We have at no time expected that the severest tests would cause the muzzles of our long rifles to droop, as we have had every confidence that the guns were manufactured on correct principles. A drooping muzzle indicates, to my mind, poor construction based on a faulty principle. The British navy experienced some difficulty of this sort several years ago with a special class of guns that lacked the stiffness that should be possessed by first-class weapons, but the drooping of the muzzles of the guns referred to was due entirely to poor construction and improper design, and not to the result of firing more rounds than the guns should properly stand. We are much pleased with the manner in which our ordnance behaved, and believe that a great majority of our guns came out of the war in as satisfactory a condition as they entered it."

Professor Alger, who has gone into the subject in closer detail than Captain O'Niel, said: "With the exception of the small rapid-fire guns, our navy rifles were not fired a sufficient number of rounds to weaken well-constructed ordnance. Even on the ships which took part in the bombardments the big rifles were fired only a few times, comparatively, and their total service during the war did not constitute any great proportion of the life of the modern high power gun of large calibre. While there is considerable difference of opinion on the point, I think it is safe to say that such a weapon as a 13-inch rifle, as they are constructed for our navy, may be fired from 250 to 400 rounds without showing any deterioration. Even then the gun does not become structurally weak. The first defect noted is the effect of the erosion of the tube near the base caused by the action of the powder gases. Sometimes this effect is seen in the erosion of a considerable area in the tube, which ultimately seriously affects the velocity and accuracy. When first developed at the base of the shell it can be remedied by using a larger metallic ring on the shell to secure a more accurate fit to the tube, but in some cases the erosion is so serious and affects such an area of the tube as to make the gun useless. Even then, it should be remembered, the gun can be re-tubed, although the process is somewhat difficult and expensive. If this operation is resorted to, however, I do not see why the life of the gun cannot be prolonged indefinitely. I believe the theory has been presented in the past that the constant firing of a gun tended to crystallize the metal composing it, thereby rendering it liable to burst. I do not think that modern ordnance experts give any serious consideration to this theory, which seems to have no basis in fact.

"With regard to the small rapid-fire guns which went through the war, I am quite prepared to learn that a considerable number of them are nearly worn out. Guns like 1, 2 and 3-pound rapid-fires are likely to show serious erosion after firing 2000 rounds, and wherever such service has been approximated we would be disposed to examine the gun with considerable care. In firing such a gun the first serious effect of erosion would be noted in the 'tumbling' of the shell, which would be quite

apparent when the gun was fired. The life of a gun in which nitro-glycine powder was used would be necessarily shorter than that in which gun-cotton was employed. We have not yet received sufficient data to determine the extent to which the rapid-fire guns approximated the theoretical limit of their efficiency, but I do not think that any very large proportion of them have suffered from the war service."

The ordnance experts are all disposed to make light of the suggestion that the Spanish artillerists kept up frequent firing from the shore in the hope of inducing the American commanders to "wear out their guns in useless bombardment, thereby rendering them inefficient when brought into play in a naval engagement. "The Spanish," said Captain O'Donoghue, "did not have ammunition to waste in any such experiment as that suggested, and I think it fair to say they knew too much of ordnance to believe that our guns could be so easily rendered ineffective. W. L. C. *The Iron Age*.

THE FRENCH NAVAL ESTIMATES.

M. Lockroy has apparently fallen in with the views of experts who argue that the only way of combating England with success is to build light and swift cruisers which will be able to wage war upon the carrying trade, and thus reduce this country to inaction by destroying commerce. For in the list of new vessels which he proposes adding to the French navy, he has comprised specimens which will no doubt satisfy even the theorist who has his own ideas on the matter. The list includes six battle-ships, thirteen cruisers, six station cruisers, two cruisers of a type that are evidently intended to serve as scouts—the utility of which is being severely criticised in some quarters—one aviso, two gunboats, one transport, eight submarine boats, twelve torpedo-destroyers, one sea-going torpedo-boat, ten squadron torpedo-boats, thirty-nine first-class torpedo-boats, and six small torpedo-boats. Of these vessels thirty-seven will be built in the State dock-yards, and the rest in private yards. Fifteen of the ships in the list are either practically complete or will be at the beginning of next year—that is to say, the battle-ships *Champlain* and *Gaulois*, the first-class station cruiser *Guichen*, the second-class cruiser *Protet*, the aviso *Kersaint*, which has been on the stocks many years that it is now thoroughly out of date; the destroyers, *Dun* and *Durandal*, the sea-going torpedo-boat *Cyclone*, which has recently exceeded thirty knots in its trials at Cherbourg, and nine first-class torpedo-boats. Of the remaining seventy-two vessels, forty-four are either on the stocks or will be by the end of the year. In his statement, Lockroy says that both the *Saint-Louis* and the *D'Entrecasteaux* will be completed in 1899; but, as a matter of fact, the latter vessel is already completing its armament, and will start for the Chinese seas very soon. The other ships to be finished next year are the first-class cruiser *Chatilaire*, the third-class cruisers *D'Estrées* and *Infernet*, eight destroyers, a gunboat, the submarine boat *Morse*, seventeen first-class torpedo-boats and six small torpedo-boats. The vessels to be completed in 1900 are the battle-ships *Henry IV.* and the *Iéna*, the first-class cruiser *Jurien-de-la-Gravière*, a gunboat, a submarine boat, and six squadron torpedo-boats. In 1901 are to be terminated the battle-ship *Suffren*, the protected cruiser *Jeanne d'Arc*, *Dupetit-Thouars*, *Condé*, *Montcalm*, *Desaix*, and *Kléber*.

and in the following year it is announced that the cruisers Gueydon, Gloire, Duplex, and Sully, will be ready to take the sea. The number of vessels to be put on the stocks in 1899 is twenty-eight, including a battleship, of which the drawings have not even yet been completed, and it is doubtful even whether a definite type has been decided upon; two protected cruisers of the Gloire and Sully class, two estafete cruisers, two destroyers, six submarine boats, four squadron torpedo-boats, and eleven first-class torpedo-boats. The cruisers of the Gloire class will have a displacement of 10,014 tons, with a length over all of 138 metres, and a beam of 20.20 metres, and will be propelled by three screws. The speed is to be 21 knots. Carrying 1590 tons of coal, they will have a range of action of 1940 miles at the maximum speed, and of 10,400 miles at 10 knots. They will have two 194-mm. guns, eight of 164.7-mm., six of 100-mm., eighteen of 47-mm., six of 37-mm., and two of 65-mm. The estimated cost of these two vessels is 21,715,641*f.* and 23,573,500*f.*, the difference being due apparently to the fact that one will be constructed in the State yards and the other by a private firm. The two estafete cruisers, which are of an entirely new type, will have a length of 120 metres, a beam of 13.60 metres, and a displacement of 4000 tons. They will have water-tube boilers, and the engines will develop 15,000 horse-power. The estimated maximum speed is 23 knots. They will have eight guns of 100-mm., twelve of 47-mm., and four of 37-mm., all quick-firing. The estimated cost is 8,766,468*f.* and 8,731,518*f.* respectively. It will be remarked that the submarine torpedo-boats of the type of the Narval, now building at Cherbourg, figure prominently in the estimates, and it appears as if the French Marine have a good deal of confidence in the efficiency of this class of vessel. The six boats to be constructed will have a displacement of 106 tons. They will be propelled by engines of 217 horse-power, and the estimated speed is 12 knots. They will have no other armament but four torpedo-tubes. The cost of each boat is 648,050*f.* The grant M. Lockroy has asked for to cover the year 1899 is 304,078,400*f.*, a matter of 17,000,000*f.* more than for the present year.—*The Engineer.*

SHIPS OF WAR.

[ENGLAND.]

H. M. S. ARGONAUT.

The trials of H.M.S. Argonaut, which commenced on the 25th of Nov., came to a satisfactory termination on the 8th inst. The engines of this ship are similar to those of H.M.S. Diadem, of which an illustration was given in a recent issue. The boilers are of the Belleville type, with economizers. The full working pressure is 300-lb. per square inch in the boilers, reduced to 250-lb. per square inch at the engines. The trials consisted of a series of two of thirty hours at 3600 indicated horse-power, one of thirty hours at 13,500 indicated horse-power, and one of eight hours at full power—18,000 indicated horse-power. The second thirty-hour trial at 3600 indicated horse-power was run to confirm the records obtained from the first trial. The following is a tabulated statement of the results of the trials:

	First 30 hours at 3600 I.H.P.	Second 30 hours at 3600 I.H.P.	30 hours at 13,500 I.H.P.	8 hours at 18,000 I.H.P.
Draught of water:				
Forward	24ft. 3in.	24ft. 3in.	24ft. 3in.	24ft. 3in.
Aft	26ft. 3in.	26ft. 3in.	26ft. 3in.	26ft. 3in.
Speed, knots	12.5	13.3	19.5	20.8
Steam pressure in boilers, lb. per sq. in.	226	258	Various	293
Air pressure in stokeholds, in. of water	—	—	—	.21
Vacuum:				
Starboard	24.8	25.8	26.7	25.9
Port	25.4	26.2	26.5	25.4
Revolutions per minute:				
Starboard	74.4	75.5	115.7	128.8
Port	74.8	76.3	116.3	128.0
Mean I.H.P.:				
High, starboard	585	613	2169	2891
High, port	568	570	2138	2869
Intermediate, starboard	470	527	1688	2413
Intermediate, port	466	586	1769	2510
Forward, low, starboard	413	379	1482	1988
Forward, low, port	385	381	1398	1921
Aft, low, starboard	444	403	1683	2319
Aft, low, port	425	356	1488	1983
Total I.H.P.	3756	3815	13,815	18,894
Consumption of coal, lb. per I.H.P.	2.13	2.02	1.6	1.6

Throughout the trials hand-picked Welsh coal was used. Experiment trials were made throughout the series, which showed the evaporation pounds of water per pound of coal to vary from 10 at low power to 11 at full power. At no portion of the trials was there the slightest difficulty, and the Fairfield Company is to be congratulated on the successful results of the trials of this powerful addition to the Royal Navy.—*The Engineer*.

H. M. S. FORMIDABLE.

H.M.S. Formidable, launched at Portsmouth on Nov. 17th, is a sister ship to the Implacable, building at Devonport, and the Irresistible, building at Chatham. These vessels, which are described as improved Majestics, were designed by Sir William White, Director of Naval Construction. The new ships are 10 ft. longer than the Majestic, which enables the draught to be reduced by 9 inches without affecting the fighting qualities; the displacement, indeed, is 15,000 tons instead of 14,900 tons. The leading dimensions are as follows: Length between perpendiculars, 44 ft.; beam, 75 ft.; displacement, 15,000 tons; mean draught, 26 ft. 9 in.; indicated horse-power, 15,000; coal capacity, 2100 tons; speed, 18 knot armament, four 12-in. guns, twelve 6-in. quick-firers, sixteen 12-pound quick-firers, two 12-pounder 8-cwt. (boat guns), twelve 3-pounder quick-firers, eight Maxims. On a less draught the Formidable carries a great store of coal, 2100 tons against 1850 tons, and though there is no difference in the weight of armament many improvements in rapidity of fire will be introduced. The Formidable will be propelled by twin screw

each screw being actuated by a set of triple-expansion engines of 7500 indicated horse-power. Steam will be supplied by 20 Belleville water-tube boilers, working at a pressure of 300 lbs. to the square inch, but the pressure will be reduced at the engines to 250 lbs. At the prescribed draught the ship will carry only 900 tons of coal, but a special feature of this type of vessel, according to the *Times*, is that the lower bunkers can be coaled independently of the upper bunkers. The side armor, which is treated by the improved Harvey process, will be 9 in. in thickness, 15 ft. in depth, and 216 ft. in length, thus providing a belt for 54 per cent. of the ship's side. The armor bulkheads, varying in thickness from 9 in. to 12 in., will be so fitted as to join the ends of the side armor, forming a complete belt round the vital parts of the ship. There are two protective decks, the principal one being of the turtle-back shape, and the armor will rest upon it at its connection in the shell-plating. It will be 2-in. plating on the flat portion, and 3-in. on the slopes and at the after end. The 12-in. guns will be protected by an 8-in. shield, and the machinery for working the guns will be protected by a 12-in. circular armored redoubt. For the auxiliary armament the Vickers 6-in. quick-firing gun has been adopted, eight being mounted on the main deck and four on the upper deck. Four of these can be fired right forward and four right aft. Each 6-in. gun will be enclosed in a casemate of Harvey steel, and the ammunition will be sent up through an armored tube, being thus under protection from the time it leaves the magazine. Eight of the 12-pounder quick-firing guns will be carried on the main deck, and the other eight on the upper deck, the 3-pounders being carried in the fighting tops. There will be four 18-in. submerged torpedo-tubes, two being fitted forward and two aft. In order to obviate any serious injury arising from the use of the ram, which is a steel casting weighing more than 30 tons, the sides forward are partly covered with a 2-in. nickel plating in addition to the ordinary skin plating, this stiffening extending from the ram to the belt. If employed as a flagship the Formidable will have a complement of 789 officers and men. She will be fitted with two steel masts, each with a military or fighting top, and with a searchlight platform on the main top-mast. A long-distance semaphore for signalling at sea will be fitted, the semaphore being about 160 ft. above the level of water-line. The masts are provided with three derricks, two forward and one on the main-mast, and these derricks, which are primarily for hoisting out the boats, will be of great utility when coaling. The boats include four steamboats—two 56 ft. in length, and two 40 ft. in length—and 14 sailing and rowing boats, ranging from a 42-ft. sailing launch to a small dinghy. The two larger boats are capable of steaming about 13.5 knots, and are fitted with torpedo-dropping apparatus. They can also act as scouts whilst the parent ship is in harbor. Three independent sets of dynamos and engines are required to light the ship, work the electric motor fans, and for the searchlights. Every compartment except the double bottom will be efficiently lighted by incandescent lamps, and Colom's lights will be fitted for use when the dynamos are not running. Ventilation will be secured by the use of motor fans outside the engine and boiler-room spaces and by steam fans in these rooms. There will also be a complete installation of electric bells, voice pipes, and loud-speaking telephones at important places. She will be engined by Earle's Shipbuilding Company. Though a 15,000-ton ship, the Formidable will displace only 4500 tons when launched.—*Engineering*.

BRAMBLE.

The gunboat Bramble was launched on the 26th of Nov. from the yard of Messrs. W. H. Potter and Sons at Liverpool. She is one of four vessels of the Thistle class, two of which are being built by Messrs. Pott and two on the Clyde, the first of which was described fully on page 563 *ante*. The Bramble's length between perpendiculars is 180 ft., and over all 187 ft. 6 in., with 33 ft. beam. At loaded draught of 8 ft. she will have a displacement of 710 tons. She is armed with two 4-in. quick-firing guns, one on the forecastle, and the other on the main deck aft; two 12-pounder quick-firing guns, one on each bow, under the forecastle, and a similar gun on each side amidships. She is also fitted with ten 45-Maxims, three on each side of the vessel on the main deck and two each of the two military fighting tops. Accommodation is provided for officers and crew of 70. She has two sets of triple-expansion engines with an indicated horse-power of 1300.—*Engineering*.

[FRANCE.]

FRENCH BATTLESHIP "CHARLES MARTEL."

We publish on page 556 a general view of the first-class French battleship Charles Martel, and on our two-page plate a section of her main engines, which were constructed by Messrs. Schneider and Co., of Crotoy. Further views will be given in a future issue. The Charles Martel was built in 1893, and the following are some particulars of this fine vessel:

Length	120 m. (393 ft. 7 in.)
Beam	22 m. (72 ft. 2 in.)
Draught (aft)	8.40 m. (27 ft. 6 in.)
Displacement	11,882 tons.
Indicated horse-power	13,500
Speed	18 knots.
Number of screws	2
Coal storage	800 tons.

Armor:

Belt	450 mm. (17.72 in.)
Turrets	370 mm. (14.57 in.)
Deck	70 mm. (2.76 in.)

Armament:

Two 305 mm. (12.01 in.); two 274 mm. (10.78 in.); eight 14 cent. (5.51 in.) q.-f.; four 65 mm. (2.56 in.) q.-f.; sixteen 47 mm. (1.85 in.) q.-f.; eight 37 mm. (1.46 in.) q.-f.

The main engines of the Charles Martel are illustrated by our two-page plate; they are vertical, with three cylinders, triple-expansion, of equal power, driving twin screws. The principal dimensions of the engines are the following:

Diameter of high-pressure cylinder.....	1.130 metre (44½ in.)
Diameter of mean-pressure cylinder.....	1.700 metre (66½ in.)
Diameter of low-pressure cylinder.....	2.680 metre (105½ in.)
Stroke	1.100 metre (43½ in.)

Each engine is provided with a condensing plant, consisting of a wrought-brass tubular condenser, three vertical single-acting air pumps, and one centrifugal circulating pump. The pumps are worked by a separate engine. The high-pressure slide valves are cylindrical, the mean and low-pressure ones are of the flat type and are balanced. All the slide valves are governed by link motion. The reversing gear can be worked by hand or steam-power. The pistons are of cast steel and are conical in shape. The foundation plates which carry the crankshaft bearings are of cast steel; the columns on which the cylinders are supported are of forged steel. All the crankshafts, intermediate, and propeller shafts are hollow, and of forged steel; the propellers are of special bronze, with blades fitted on. Each engine-room is provided with two ventilators, one for delivering fresh air in the engine-room, and one for exhausting the hot air. The condensed water delivered by the air pumps of each engine is collected in a tank provided with filters, whence it is delivered again into the boilers. Special evaporators serve for producing fresh water to make good the loss. There are 24 boilers of the Lagrafel and d'Allest type, as prescribed for this battle-ship, placed in four stokeholds; the boilers being connected with two funnels.

Registered steam pressure.....	15 kilos. (213.3 lb. per sq. in.)
Total grate area	95.20 sq. m. (1024.8 sq. ft.)
Total heating surface including that not covered by water	3000 sq. m. (32,292 sq. ft.)

The boilers are fed by eight Thirion pumps, worked by separate engines. The ventilation of the stokeholds and the forced draught are provided for by eight fans.

The maximum total power prescribed was 13,500 horse-power, at 95 revolutions, with a maximum steam pressure of 12 kilogrammes (170.7 lb. per square inch) in the steam chest. The trials gave the following results:

Duration of trial, hours.....	6	6	4	24	6
Number of engines working.....	2	2	2	2	2
Number of boilers working.....	8	16	24	24	24
Average revolutions	52.4	70.5	97	87.5	92.7
Total horse-power	2186	5545	14,931	9800	12,620
Coal consumption per horse-power per hour, kilogs	0.762	0.624	0.796	0.753	0.736
Coal consumption per horse-power per hour, lb.	1.68	1.38	1.76	1.67	1.63

—Engineering.

THE FRENCH BATTLE-SHIP BOUVET.

The Bouvet, which is an improved Charles Martel, which again is an improved Jauréguiberry, is the largest and finest ironclad at present in the French navy. She was laid down in January, 1893, launched in April, 1896, and completed for sea early in this present year.

The armament comprises two 12-in. guns in turrets for and aft; two 27-centimetre—10.8-in. exactly—in turrets, one on either beam; eight 6-in. quick-firers, in eight separate turrets; eight 4-in. quick-firers, disposed upon the upper deck behind shields of hardened steel; twelve 3-pounder quick-firers; and twenty 1-pounder quick-firers.

There are three above-water and two submerged torpedo-tubes—one of the former in the stern. The 12-in. guns are 40 calibres long and 46 tons in weight. The velocity is very high, 2625 both for these and for the 27-centimetre guns, consequently excellent shooting is made with them. The 27-centimetre guns are 45 calibres in length. The nominal muzzle energies are respectively 30,750 foot-tons and 22,750 foot-tons. Both sorts are in the first rank of armor-piercing guns, and have a penetration equal to most armor afloat at near range. Roughly, the actual service penetrations at 2000 yards may be put at 24-in. and 18-in. of iron respectively. We have in the plan adopted the naval war game system of gun and armor notation. By this all guns and armor are reduced to a single-lettered approximation based on what, roughly, the gun can penetrate with armor-piercing shot at 2000 yards, the index letter to the armor signifying that it is proof against any gun of an inferior letter. Thus *b* armor must be attacked by a B or A gun. For hasty reference this system is convenient, and presumably approaches the actual sufficiently nearly for practical purposes.

The armor of the Bouvet is distributed as follows: A complete belt, the top of which is on the water-line 16-in. to 8-in. Creusot steel, which is equivalent to Harvey armor in resisting power. Behind this belt is a 3½-in. deck, curved like that of the Majestic, which gives a further resisting value equal to about 12-in. vertical iron armor. Consequently the engines have a protection altogether equivalent to vertical iron armor 44-in. thick or more. Even the gun tables allow this as muzzle penetration to very few guns, in actual practice we may safely say nothing could possibly get through it. Fairly safely, too, we may call this excessive protection a waste of armor that could better have been placed elsewhere. Below, again, is a splinter deck. Above this thick belt, covering up to the base of the main deck forward and to a similar height under the amidship turret nest, elsewhere about 3 ft. above the water-line, on a level with the top of the armor-deck, is a thin belt 4-in. thick. This belt is incomplete, stopping some 50-ft. from the stern in the Bouvet, though the other ships of the class have it complete.

The big gun turrets have 14½-in. armor. Their bases are unprotected, but the hoists are about 4-in. thick—the exact thickness of these is doubtful. The turrets revolve around these hoists. The weak point of the design is the havoc a big shell would wreak bursting anywhere under these turrets. The small turrets and their hoists are all 4-in. thick—susceptible to 6-in. solid shot—a weak point again. The shields for the 4-in. guns are about 2-in. thick of special hardened steel. There are three conning towers, one at the base of each mast and one abaft the after funnel; all have about 10-in. of armor. Melenite shell are carried for all guns of 4-in. and over in the Bouvet.

The target she offers is very big. It is very problematical how the 4-in. guns would fare in action. The illustrations indicate clearly the positions of the guns. A weak point in the Bouvet, which French critics draw attention to, is the amidship west of turrets. There seems a strong chance that one single shell, of no very large calibre, bursting under the central turret would jam all three. On the other hand, the ship's fighting position is at an angle, and in such case the base of the big upper turret is well enough protected by its smaller companions.

The Bouvet has three sets of triple-expansion engines, each actuating a screw. The boilers are of the Belleville type. The ship has done so

many trials that it is difficult to select any one result as her "trial speed," a mean of 18 knots has been frequently obtained. The twenty-four hours' trial, at sea with the ship at her proper displacement, produced from 17 to 17.5 knots. This is very good, indeed. Our only battle-ship able to equal it is the *Renown*, which has lately been cruising at 17 knots; but the *Renown*, with her inferior big guns, would not stand a very good chance against the *Bouvet*: she would be powerless, that is, against the Frenchman's armor, while her own would be liable to penetration at 4000 or even 5000 yards. On the other hand, the *Bouvet* is ill-adapted to stand shell fire. Like nearly all French ships, the *Bouvet* could not be sunk by gun-fire, but shell might wreck her all to pieces. Ours are in more danger, speaking generally, of being sunk than wrecked by gun-fire. There is a suggestive proverb about this in our service; but at the present time of heated sentiment it need not be repeated. It suggests reflection, however.—*The Engineer*.

THE FRENCH BATTLESHIP *MASSENA*.

The *Massena* carries an armament identical with that of the *Bouvet*, fully described last week—two 12-in., two 10.8-in., eight 5.9-in. quick-firers, and eight 4-in. quick-firers. The latter guns are, however, carried quite differently, and possibly better placed. Having the large French ram bow, the *Massena* differs a good deal from the *Bouvet* in general appearance, and her design having been worked out independently of that ship there are other differences of details also. The boilers are Lagrue's—*D'Allest*—the *Bouvet* has *Belleville*. The funnels of the two ships are very differently placed, and the *Massena* has a large number of big cowls, the *Dupuy de Lôme* being the only ship that approaches her in this respect. On trial the *Massena* made very near 18 knots, but the enormous bow wave caused trouble. She has, however, run 17 knots continuously at sea. The armor of the *Massena* is identical with that of the *Bouvet*, save in one particular—the belt aft is incomplete.

[RUSSIA.]

GENERAL ADMIRAL *APRAK SIN*.

The second trial of the engines of the Russian coast defence battle-ship General Admiral *Apraksin* has taken place with good results. The war-ship made four runs on the measured mile, and the mean speed realized was 15.07 knots. During a seven hours' continuous run of the engines at full power, no interruption in the regularity of the working was observed. During the trial nine sets of diagrams were taken, and these indicate that the engines on this occasion realized more than the 5000 horse-power required by the contract. The indicated horse-power, as shown by the ninth sets of diagram was as follows: Port engine, high-pressure cylinder, 806.17; intermediate, 997.80; low, 1028.60; total, 2832.57. Starboard engine, high-pressure cylinder, 817.63; intermediate, 1026.78; low, 1080.42; total, 2924.83. The number of revolutions of the port engine was 123, and the pressure of steam 128.4 lb.; of the starboard engine, revolutions, 124; pressure of steam, 133.2 lb. The grand total indicated horse-power was 5757.40. At the first trial the indicated horse-power fell short of that contracted for, and the contractors at the Franco-Russian works became subject to a fine of 2920*l*. The makers attribute the deficiency of

BOOK NOTICES AND REVIEWS.

TEÓRIA VÉROYATNOSTIE É PRĚMĚNĚNIA ÉA K'STRĚLBĚ É PRĚSTRĚLBĚ.

THEORY OF PROBABILITIES AND ITS APPLICATION TO FIRING AND REGULATION OF AIM, by Colonel N. Zaboudski, Permanent Member of the Artillery Committee, Professor in Ordinary at the Michaelovsk Artillery School, Pub. Saint Petersburg, Press of the Imperial Academy of Science, 1898.

This work constitutes the second half of Colonel Zaboudski's treatise upon Exterior Ballistics, the first portion of which appeared in print about a year ago. In an octavo volume of 400 pages, are discussed at length those theorems in probabilities applicable to the classification and evaluation of groups of experimental data obtained as the results of gun-firing. The scope and nature of Colonel Zaboudski's treatise are clearly set forth in its preface, a translation of which is hereto appended, as illustrating the character of the work.

"The theory of probabilities and its application to firing and to the regulation of aim constitute the 2nd section of the course taught by me at the Michaelovsk Artillery Academy. The subject is here developed to such an extent as to afford artillerists a means of acquaintance with the fundamental principles of the theory of probabilities, through the method of least squares, and by processes convenient for the investigation of results of firing and pointing."

"The work is subdivided into five chapters and five appendices."

"In Chapter I the fundamental principles of the theory of probabilities are stated; my exposition of them is based in the main upon notes made by me at the lectures of the Academician P. L. Tchebishev, which I attended in 1880-81, at the St. Petersburg University."

"Chapter II discusses the method of least squares; in preparing it I have utilized General Maievski's work, 'Exposition of the Method of Least Squares,' 1881, supplemented by a few theorems. The proof of the principle of the arithmetical mean for a very great number of observations, is based upon Tchebishev's theorem, while a second proof of this principle is also deduced, based upon the determination of the probability, that the sum of the observed values lies between given limits; by this it is shown that the most probable value of the unknown quantity is the arithmetical mean of the observed values."

"The proof of the principle of the arithmetical mean for a very great number of observations is independent of the form of the function expressing the probability of error of observation. The form of this function is determined on the assumption of Gauss, that the most probable hypothesis relating to the quantity under measurement corresponds to the arithmetical mean of its observed values. Upon this assumption is based the solution of various problems related to the method of least squares."

"The Chapter concludes with the presentation of explanatory numerical examples, one of which is connected with ordnance investigation, namely the preparation of the data resulting from firing the 4.2 gun provided with side pressure gauges for measuring pressures developed by smoke powder gases at various sections of the bore."

"In Chapter III the theory of probabilities is employed for the study of results, from firing solid shot and shrapnel."

"The chance of deviation of a projectile from the centre of grouping upon a plane and in space, is deduced in accordance with the assumption of Biais and Schols,* that the causes producing the deviation of a projectile from the center of grouping are very many, and that all may produce deviation indiscriminately in any direction. Such a method of determining the chance of deviation of a shell was followed by the Italian Major of Artillery (now Senator) Siacci, and the French General of Artillery Pioutz in investigating the results of firing."

"In order that deductions based upon the principle of the arithmetic mean may be applied to correcting results of observations it is necessary to equate directly results from practice with those deduced theoretically. Examples are adduced from various authors illustrating the possibility of applying the method of least squares to the investigation of the results of firing; in addition thereto I have presented my own study, in accordance with this method, of data obtained from firing the 12-cm. (4.72-inch) heavy siege gun at the Krupp works, Dec. 1880. The tables of the French artilleryman Lardillon, are employed for determining the number of hits resulting from firing a group of shrapnel."

"Chapter IV treats of the employment of the theory of probabilities in investigating problems for the regulation of firing. This chapter is an arrangement of lithographed notes prepared by me in 1880 for use at the Michaelovsk Artillery Academy, in compiling which I utilized the investigations of the French artilleryman Persain, the Belgian artilleryman Mangon and articles by Lieut.-Gen'l Shklarevitch."

"In the solution of problems relating to the correction of fire the case of shell with percussion fuses and of shrapnel are both considered."

"The correction of aim can only be based in most cases upon the knowledge of the direction of deviation of the shell from the target, but in fortress and siege firing, cases may be met where the correction of aim is based upon actual measurement of such deviation. Two methods of correction are therefore to be considered; (1) that based upon measurement of deviation, (2) that based upon the ratio of shorts to overs. Persain and Mangon's method is employed for the investigation of the latter case. Mangon's method is also applied to the case where the firing is corrected by measuring the deviation of one group of shots, and by determining the ratio of shorts to overs for another."

"Errors in observation are taken into account in the correction of firing; and the chances of firing short and over are discussed for the case where such an error is recognized."

"For illustrating the application of the theoretical method to the correction of aim, some of the rules adopted by us for firing at a moving target are discussed."

"Chapter V presents Tchebishev's formulæ for interpolation by the method of least squares as applied to the solution of normal equations."

*Professor at the Delft. Polytechnic School. Note upon Probability in Firing. *Revue d'Artillerie*, Feb., 1884.

by the aid of indeterminate coefficients, followed by examples taken from the French artilleryist Jouffré."

"Appendix I presents the development $\sin x$ in infinite series in x ."

"Appendix II gives the integration of the expression representing the degree of accuracy of observations in terms of the n th degree of the errors."

"In Appendix III is presented Laplace's corollary, that for a very great number of observations the most probable value of the unknown quantity, expressed in equations is determined by the method of least squares, independently of the form of the function expressing the chance of error in observation, and based upon the two first theorems of the theory of probabilities—summation and multiplication."

"Appendix IV contains deductions based upon the rule of mean value. In consequence of the investigations of the French artilleryist Etienne, articles have appeared in our ordnance literature that do not elucidate this rule with sufficient clearness; I therefore discussed Etienne's work, and expounded those scientific deductions relating thereto."

"The rule of mean value has long been known, but its employment ceased upon the discovery of the method of least squares, in view of the indisputable superiority of the latter method."

"Appendix V consists of tables."

$$* \sin x = x \left(1 - \frac{x^2}{2!}\right) \left(1 - \frac{x^4}{4!}\right) \left(1 - \frac{x^6}{6!}\right) \dots$$

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A prize of one hundred dollars, with a gold medal, is offered Naval Institute for the best essay presented on any subject per to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of C voting by ballot and without knowledge of the names of the comp
2. Each competitor to send his essay in a sealed envelope to the tary and Treasurer on or before January 1, 1899. The name of the shall not be given in this envelope, but instead thereof a motto. / panying the essay a separate sealed envelope will be sent to the Se and Treasurer, with the motto on the outside and writer's nan motto inside. This envelope is not to be opened until after the d of the Board.
3. The successful essay to be published in the Proceedings of t stitute; and the essays of other competitors, receiving honorable m to be published also, at the discretion of the Board of Control; : change shall be made in the text of any competitive essay, publi the Proceedings of the Institute, after it leaves the hands of the
4. Any essay not having received honorable mention, may b lished also, at the discretion of the Board of Control, but only w consent of the author.
5. The essay is limited to fifty (50) printed pages of the Proceedi the Institute.
6. All essays submitted must be either type-written or copied clear and legible hand.
7. The successful competitor will be made a Life Member of the tute.
8. In the event of the Prize being awarded to the winner of a pr year, a gold clasp, suitably engraved, will be given in lieu of : medal.

By direction of the Board of Control.

GEO. F. COOPER,

Lieut., U. S. N., Secretary and Treasur

ANNAPOLIS, MD., January 1, 1898.

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VOLUME XXIV.



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ANNAPOLIS, MD.

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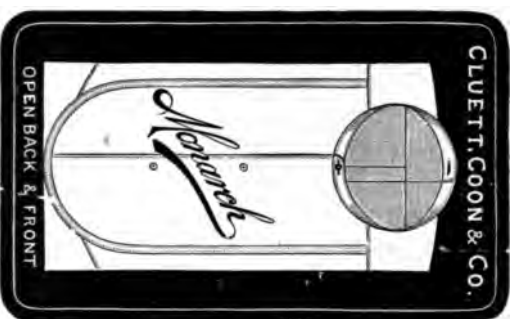
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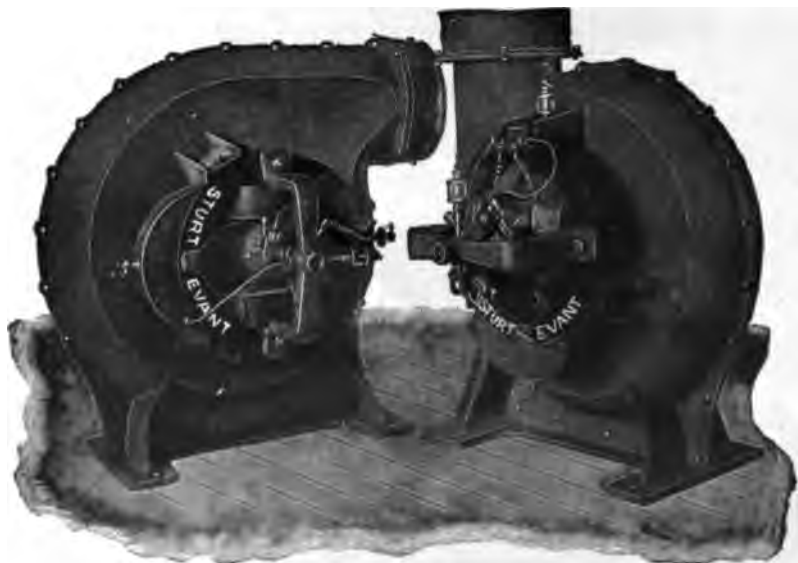
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On the subject of membership the Constitution reads as follows:

ARTICLE VII.

Sec. 1. The Institute shall consist of regular, life, honorary and associate members.

Sec. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members, without ballot, on payment of dues or fee to the Secretary and Treasurer, or to the Corresponding Secretary of a Branch. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

Sec. 3. The Prize Essayist of each year shall be a life member without payment of fee.

Sec. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control, and a vote equal to one-half the number of regular and life members, given by proxy or presence, shall be cast, a majority electing.

Sec. 5. Associate members shall be elected from officers of the Army, Revenue Marine, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

Sec. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

Sec. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control, and, if their report be favorable, the Secretary and Treasurer shall make known the result at the next meeting of the Institute, and a vote shall then be taken, a majority of votes cast by members present electing.

The Proceedings are published quarterly, and may be obtained by non-members upon application to the Secretary and Treasurer at Annapolis, Md. Inventors of articles connected with the naval profession will be afforded an opportunity of exhibiting and explaining their inventions. A description of such inventions as may be deemed by the Board of Control of use to the service will be published in the Proceedings.

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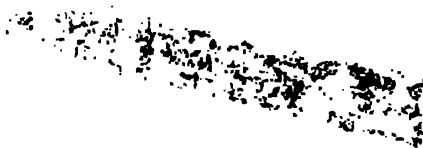


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